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An Assessment of Mobile Fitness Games

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An Interactive Qualifying Project

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Abstract

The purpose of this project was to find, document, and review mobile fitness games from the Android and iTunes marketplace, with a focus on those that encourage physical exercise. Using a variety of marketplaces and web searches, we, among a group of recruited and willing participants under study, played and reviewed Android and iPhone games that featured movement as an integral part of the game. We reported how effective the game is for fitness, and how engaging the content is for players. We provided reviews that can be used by: 1) Individuals seeking an enjoyable method of achieving a certain level of fitness, and 2) Game developers hoping to produce a compelling mobile fitness game of their own.

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1. Introduction

Obesity in the United States, along with similar industrialized countries, is consistently increasing.[i] According to the Centers for Disease Control and Prevention, more than 35.7% of U.S. adults are obese, placing themselves at immense risk of heart, diabetic, and other medical issues.[ii] The percentage of adults that meet the minimum requirements for the Physical Activity Guidelines of both aerobic and muscular physical activity is only 20.6%. In a similarly increasing trend, the number of smartphone users is increasing. A study conducted by PewInternet from 2013 found that the percentage of adults who own a smartphone is currently at 56%, and is rapidly climbing.[iii]

Smart phones are used for a variety of applications. Some people reserve their phone simply for calls and text-messaging, but according to an infographic, roughly 69% of these users download and launch apps, including mobile games.[iv] In general, these applications are simple and casual, only requiring a short time to learn to operate. Many mobile apps are video games, social networking applications, or personal management suites. Smart phones generally contain GPS functionality, which enable these apps to integrate movement-based algorithms into their design.

Due to the increasing issues of physical fitness alongside the incredible growth of smartphones and smartphone apps, a series of health and fitness games have been released for phones. These games aim to improve health while providing the user with a quality level of enjoyment, but most of these are basic, dull fitness apps. Even the interesting and well developed health games are imperfect, lacking a large player base. For instance, "Zombies, Run!", one of the most popular mobile fitness games, reports 100,000-500,000 installs on Android devices[v], but "Candy Crush Saga," a casual puzzle game, reports 100,000,000-500,000,000 installs[vi].

If the player base for health games grew similar to other mobile games, many more individuals could improve their health. As such, the focus of this project is to promote health using fun and interactive mobile video games. With the large amount and variety of applications available through the internet, individuals may not be aware of the health and fitness apps they could use to improve the quality of their life. They may also have trouble finding an app that is not only healthy, but enjoyable as well. Along with this, the currently available health games may require changes in design and execution. As this is a relatively unexplored field, there is much room for improvement in these games.

Eliminating the obscurity and flaws of current health games can greatly improve the quality of health in individuals. If every single individual with a smart phone used a health game, and enjoyed it,

many more individuals would meet the base requirements set by the Physical Activity Guidelines. This could lead to a much more acceptable percentage of fit people.

1.1 Target Audience

Both individuals seeking healthy games, along with mobile game developers looking to create a health game should take the time to read through our gathered reviews and data. The reviews performed have been documented in this report, are freely available for reading, and may be in use starting from the submission date. Individuals who read through our reviews will, hopefully, find a game they can enjoy that promotes health in some aspect. Those who are generally disappointed with the fitness apps they have found may find a great alternative in a review. Game developers should listen to the criticism offered from the reviews in order to avoid mistakes of the past, while keeping an eye to the details of what may make a game great.

1.2 Objectives

1) We used the internet to find a large collection of interesting games, searching for recurrent themes throughout the collection. Based upon these common themes, along with research into the metrics of video game reviews, we developed a review framework for studying, measuring, and determining the value and appeal of health games.

2) We conducted extensive reviews of a variety of mobile health games available for the Android and iPhone platforms, using our review framework. A selection of these games has been studied for a more in-depth analysis.

3) We supplemented these reviews with user studies in order to better understand how individuals perceive a selection of these mobile games in terms of their appeal, quality, and usefulness for becoming more active. Participants were asked to play a specific game, and afterward performed a survey to the best of their ability. Qualitative data was structurally documented. Participants were asked to play only freely available games and were not be asked to play games with a price.

4) We have provided a set of recommendations for mobile health game developers to produce and develop games that are appealing and useful for the target population, based upon an analysis of our reviews and user studies.

2. Background Review

This chapter provides an overview of the key areas in this project. The reader will develop an understanding of the current issues in health and fitness, and the option to use mobile phone games in order to provide entertaining physical exercise. Information provided in this section will cover modern problems in fitness, the technology and uses of smart phones, and mobile fitness games that have been created.

2.1 Health and Fitness

A healthy diet, exercise, and an adequate amount of sleep are essential to a healthy mind and body. According to the Meriam-Webster dictionary, fit can be defined as "physically healthy and strong." The President's Council on Fitness states that sports, nutrition, and a healthy diet (coupled with being physically fit) can result in "a healthy heart, strong bones, a sense of well-being, a good social life, and looking and feeling better"[vii] A fit individual is better acclimated to their environment and has a higher chance of living a happier and healthier life.

Proper diet and exercise lower the risks of heart disease and type two diabetes. Doctors Cornelissen and Smart (2013) conducted a study and published an article in the Journal of the American Heart Association. The participants involved undertook endurance, dynamic resistance, and isometric resistance training. In this article they found that after a 4 week trial (involving 93 participants ages 18 and higher) the participants involved showed improvements in their diastolic and systolic blood pressures.

According to the Diabetes Center at the University of California (located in San Francisco) "Eating a healthy diet, being physically staying active, and losing any extra weight is the first line of therapy... it makes your body's cells respond better to insulin (in other words, it decreases insulin resistance) and lowers blood sugar levels." One of the best treatments for diabetes is getting healthy. Having the body less likely to resist insulin can be incredibly helpful in regulating blood sugar.

Americans have been trending toward increased rates of obesity and poor health. The Physical Activity Council claims that (between 2007 and 2012) inactivity rose 2.4% in America. Approximately two and a half percent may not seem like a large number; however, this adds up to a staggering increase of 8.8 million Americans. As of 2012 the inactivity total was 23.9%, which means around 61.8 million Americans are leading sedentary lives.

Shockingly, based on results published by the Centers for Disease Control and Prevention (CDC), in 2010 35.7% of American adults were found to be obese. According to the CDC "obesity increases the risk of a number of health conditions including hypertension, adverse lipid concentrations, and type 2 diabetes." This is a major and complicated issue in America with fast food joints so cheap and easy to access, as well as an ever increasing trend toward a cramped, sedentary, urbanized lifestyle.

2.2 Smart Phones

Modern smart phones come in many models, which can easily be broken into categories based on by their operating systems (OS). Currently, the two major OS's that make up a large portion of the smartphone market are iOS and Android. iOS is Apple's operating system used on its iPhones, iPad's, and a few other Apple products, with the current version being iOS 7. Android's OS, developed by Google, is self-titled and is featured on many current smart phones. Other OS's that make up smaller percentages of the smartphone market include the Windows Phone OS, Blackberry, and Palm OS. However, Apple and Android makes up the larger part of the market.[viii] For this project, our focus is solely on applications associated with Apple and Android.

Applications on Apple's iOS are downloaded through the App Store. The App Store was introduced in 2008 and set the standard for a repository for users to browse, purchase, and download applications. The App Store features apps broken down into categories and a search function based around the input of keywords chosen by the user, such as "health" or "game." There are over 900,000 different apps available on the App Store currently. The App Store is limited to only Apple products.

The Android OS uses Google Play as its primary app distribution channel. The Play Store, a pre installed app featured on Android phones, allows users to download apps from Google Play. Unlike the App Store, Google Play can be accessed on Apple products as well, even though the content that is available is limited, with only books and music available for download.

On the current OS for Apple's iPhone, iOS 7, there is a function called "location services" which allows certain applications the ability to determine a user's location to a certain degree. This is made possible due to information gathered by the phone through cellular data, Wi-Fi, GPS, and iBeacons. iBeacons utilize Bluetooth technologies to create and monitor beacons that display certain

identifying information. These technologies allow the iPhone to have a general idea of the user's location, which many fitness/running apps utilize to track distance, speed, and other statistics.

For Android products, the types of technologies used to determine location vary depending on the specific device. According to Consumer Reports, the highest rated phones that feature an Android OS are the Samsung Galaxy S 4, the LG Optimus G, the Motorola Droid Razr Maxx HD, the HTC One, and the Nokia Lumia[ix]. These five phones all scored above a 75 out of 100 and are available from many of the major mobile carriers. Most phones feature GPS, Bluetooth, and Wi-Fi, only differing from the Apple iPhone in the lack of iBeacons.

2.3 Games for Health

This final background section will define health games and cover the history of video games designed for fitness. The current health games technology and design approaches will also be examined. Then the effectiveness of these games will be discussed.

2.3.1 History of Health Games

Health gaming, also referred to as exergaming, is a genre of video games that are played and controlled through physical actions and exercise. The history of exergames dates back to the early 1980s, near the time games began to generate mass popularity.[x]

The evolution of exergaming was interwined with some of the beginnings of virtual reality games. Autodesk began the genre with two game systems, HighCycle and Virtual Racquetball.[xi] HighCycle used an actual bike that portrayed a virtual landscape, and its speed varied on the user's pedaling. The game featured an Easter egg where the player could fly off the land. Virtual Racquetball used tracking software to track a physical racquet that the user would swing to hit a ball. This game allowed for two players over a phone line. Both games featured a head-mounted display to provide players with a more immersive feel. These games, however, were never mass produced and remain relatively unknown.

Atari, in 1982, began work on the Puffer Project, later to be named Exertainment. The Puffer was to be an exercise bike device, or an exercycle.[xii] The Puffer would feature handlebar grip controllers with turning, a wheel speed pickup for pedaling, and the correct attachment to interface it with an Atari 5200, 400/800, or VCS 2600. This device was designed to fit onto existing exercycles as attachments, and as a result the cost for a home unit would have been relatively cheap at $15. Atari had

Figure 1 -The Puffer System [1]

planned to reach a completely new and demanding target audience for their system. They would have established that the Puffer was healthy and fun, and would have reached out to the professional exercise market for potential use. Along with this, Atari had plans for an arcade version and a professional version along with the home model. Atari was very close to production with a few innovative games, but unfortunately, the video game crash of 1983 greatly hurt Atari, and they were forced to declare bankruptcy.

The first true exergaming system to be successfully released into the market was the Computrainer in 1986.[xiii] The Computrainer based itself heavily on the Puffer Project's design, where an exercycle is used as a controller. The Computrainer was released for the Nintendo Entertainment System, or NES, and tracked statistics such as pedaling speed. The product is less of a game and more of a technical tracker, and remains rather unknown in the market despite its continued existence across other platforms. Similar to this, the company Concept II developed a rowing attachment for computers to provide virtual rowing.

In 1987, Exus released the Foot Craz controller for the Atari 2600.[xiv] The Foot Craz controller was a floor mat game pad utilizing five microswitches that the player would active by stepping onto. The controller was compatible with two games, also released by Exus and bundled with the controller; these were Video Jogger and Video Reflex. Video Jogger would require the user to run on the pad, while Video Reflex would randomly flash a color on the screen, which corresponded to where the player would have to step on the pad. Exus only released these products, and they did so at the end of the Atari 2600's lifespan. Because of this, only a few Foot Crazs were ever sold.

Figure 2 - Foot Craz [2]

Following this, in 1988 Nintendo released the Power Pad controller, also known as the Family Trainer or Family Fun Fitness.[xv] It was a floor mat device developed by Bandai, similar to the Foot Craz, but a bit more sophisticated, with two different sides. Each circle, as illustrated below, contains a pressure sensor, acting as a button for a player's foot.

Figure 3 - Power Pad Side B [3]

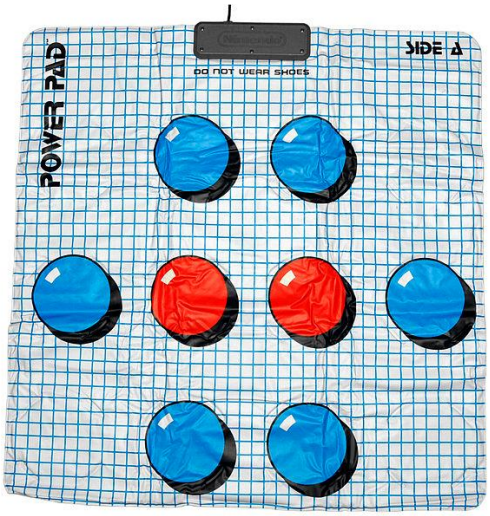


Figure 4 - Power Pad Side A [4]

Bandai developed ten games for use with the Power Pad, and Nintendo developed one. The games released were Athletic World, Running Stadium/Stadium Events/World Class Track Meet,

Dancing Aerobics, Jogging Race, Meiro Daisakusen, Street Cop, Super Team Games, Totsugeki! Fūun Takeshi Jō 1 & 2, Rai Rai! Kyonshis: Baby Kyonshi no Amida Daibōken, and Short Order/Eggsplode. While a few of these were designed to be more of an exercise simulation than a game, a multitude of these featured an interesting and unique challenge. For instance, in Street Cop the player had to chase criminals by controlling a police officer through the appropriate buttons on the Power Pad. Despite the assistance from Nintendo in publishing and re-branding Bandai's products, the Power Pad was unfortunately rather unsuccessful as well.[xvi]

Soon, interest and development into virtual reality boomed. Nintendo and Life Fitness teamed together to produce the Exertainment System.[xvii] This was another system that used an exercycle to provide input to a selection of games. The Exertainment System plugged directly into the Super Nintendo Entertainment System (SNES), and featured parts of the regular SNES controller onto the handlebars. Two games were produced for the system; the Exertainment Mountain Bike Rally and Speed Racer, where Speed Racer could be bundled with the previous game in a combo cart. Despite having good build quality and the games able to use the SNES' more powerful content, the games were too poorly developed and players lost interest.

Figure 6 - Exertainment Exercycle

Figure 5 - Mountain Bike Rally [5]

Cybergear Inc. would soon produce a standalone virtual reality bike, utilizing its own screen.[xviii]

They released their product as the Tectrix VR Bike, and it allowed users to explore different environments. The bike supported future software, with later games offering new environments along with multi-player through a direct connection and different gameplay. The VRClimber was soon released afterward, for those that preferred it over pedaling. The company released a total of seven products on CD, including Sweeney Town, St Benjamin, Penguin Peak, and Rocky vs. the Firebugs, Deep, Aztec 2000, and Tank. These games offered 3D graphics, a relatively new feature at the time. The company would continue to offer similar products under the name of Trixter.

Figure 8 - Tectrix VR Bike [8]

Figure 7 - Tectrix Game - Deep [7]

Many other companies avoided the video game end of the spectrum and directly entered the virtual reality segment. Companies would attach a screen component to an exercise bike, such as an LCD or CRT, which would allow users to essentially have a television readily available to them. Netpulse provided users with a method to access the internet while exercising, and Fitlinxx used a combination of sensors with specific weight machines to give users quick feedback on their workout progress.[xix]

These companies would end up relatively unsuccessful. As home products, these devices were far too expensive for the general user. Gyms and health clubs were rather conservative and rejected any of these new bikes and devices. The machines and games were also unsuitable for arcades.

Despite the recent failures of exergaming, Konami developed and released Dance Dance Revolution, or DDR, in 1998.[xx] It was released as an arcade machine, with a platform for the player and a cabinet for the game. Each platform has two sets of directional arrows, covered by acrylic glass

and containing pressure pads underneath. The arcade machine features quite a bit of nifty features, such as glowing neon lamps, large floor speakers, flashing cathode lamps on the pad, and more. The game itself draws arrows from the bottom of the screen to the top, and the user must step on the arrow at the appropriate time. The player is judged on how well they timed their step. Missing steps will drain a gauge that can result in a game being over; otherwise the player will be given a grade letter and a score. The game supports two players and contains music from both licensed artists and Konami's own musicians. The game has been incredibly successful and has helped addicted players lose quite a bit of weight.

Figure 9 - Dance Dance Revolution Cabinet [9]

Despite previous failures in the area, a UK start-up named Exertris brought another gaming exercycle to the world.[xxi] It was developed by PhD Physicist Gareth Davies, in the hopes of solving health issues relating to cardiovascular exercise. The exercise bike incorporated several built-in games, an LCD screen, and a hand-held controller, along with a unique design that could alter the levels of the screen and arm-rest to ensure correct posture as the user exercised. The game could be operated as a general exercise bike under a manual option. The games developed for it included Gems, Orbit, Space Tripper, a biking version of Solitaire, Maze, and Light Cycles. While previous exercycles were unpopular, the Exertris bikes were well received. Bill Gates demonstrated the bike at the Consumer Electronics Show in 2003, and in 2004 the show demonstrated the technology again.[xxii] Unfortunately, the manufacturing cost of the bike was high while the price cost was low, and after losing funding the

company was forced to close in late 2004.

Figure 10 - Exertris Bike [10]

In 2005, Playstation released the EyeToy: Kinetic for the Playstation 2.[xxiii] The EyeToy itself is a webcam device used to track players in front of their television. The player can see themselves reflected on the screen, with additional images and graphics depending on a game. EyeToy: Kinetic featured four different zones for the player to choose from; Cardio, Combat, Toning, and Mind and Body. The Cardio Zone, used for improving cardiovascular fitness, generally involved games that required the player to follow a trail of discs. The Combat Zone was designed for strength, endurance, and flexibility fitness, and required the destruction of incoming projectiles. The Toning Zone was built for aerobic exercise, and features actual exercises. The Mind and Body Zone is more of a relaxation section, with a few mind games and meditation methods. The game also offered a personal trainer to assist in exercise, with routines and grades. Despite receiving a fair reception, it never reached a critical amount of players.[xxiv]

Figure 12 - Playstation Kinect [12]

Figure 11 - Playstation 2 Eyetoy [11]

In 2006, Nintendo launched their Wii console.[xxv] The Wii console uses a unique controller called the Wiimote, which contains Bluetooth connectivity with three-axis acceleration detection and infrared sensors (and later gyroscopes) along with a Nunchuck attachment that also utilizes an accelerometer for motion-sensing and tilting. By using these Bluetooth peripherals as controllers for the Wii, Nintendo opened a large market for fitness games. A balance board was also released later as an extra device for determining a user's balance. Wii Sports, a game which could optionally be bundled with the console and used the Wiimote and Nunchuck, featured virtual tennis, baseball, bowling, golfing, and boxing games that required the user to move and exercise their arms. The game is the most popular Wii game, with an estimated 82.98 million copies sold. Near this, Wii Sports Resort, Wii Play, and the Wii Fit games come close, with sales in the tens of millions. Many other developers have also produced their own games using the Wiimote and Nunchuck. Players who remain dedicated to these games report an improvement in health and weight loss, but unfortunately many people play the games too casually and without enough dedication, resulting in little improvement to fitness.

Figure 14 - Nintendo Wii Console [14]

Figure 13 - Wii Sports Gameplay [13]

In response to this, PlayStation developed the PlayStation Move for the PlayStation 3 and released it in 2010.[xxvi] The PlayStation Move is a controller using a variety of internal sensors to determine motion-sensing, and uses a magnetometer for location tracking. Most notable is the orb that glows at the top of the controller, which emits a spectrum of different colors, which is then tracked by the PlayStation 3's camera. A popular game that PlayStation Move offers that promotes fitness is the Dance Dance Revolution bundle, which requires a dance pad. Playstation also offers The Fight: Lights Out, as a boxing game that reports the number of calories burned. Despite having higher accuracy than its Wiimote competitor, the PlayStation Move lacks a large player base, and its reception is nowhere near as critical. There is an estimated 15 million sales of the device alone. [xxvii]

Figure 15 - Playstation Move Controllers [15]

Microsoft also developed its own motion sensing device, named Kinect, for the Xbox 360.[xxviii] The Kinect uses an infrared projector and camera to track movements of objects in three dimensions. With this, all the player must do is move their body and make gestures in front of the camera, and the Kinect is able to fully track them. The Xbox 360 offers Kinect games such as Your Shape: Fitness Evolved, EA Sports Active 2, and The Biggest Loser Ultimate Workout to help improve fitness. These games contain algorithms to analyze the player's body shape and track progress, along with determining calories burnt and other vital data. The game Dance Central, which requires the player to truly form positions and dance, also aids in fitness. The Kinect has achieved 24 million units in sales, surpassing the PlayStation Move. [xxix]

Figure 16 - Kinect Sports Gameplay

The success of health games in the home console industry has crosssed into mobile phones. Currently, there are tens of thousands of health and fitness apps for both the Android and iPhone market, with the top apps featuring millions of users. Many of these apps, however, are more of a fitness tracker than an actual game. While many may enjoy some of the handy features in these trackers, such as personalized coaches and data tracking, many others do not. There are a few true games available though that place a genuine effort to get a player engaged and hooked into fitness.

2.3.2 Previous Studies on Health Games

Prior to this project, there has been very little research from previous project (IQP or MQP) groups related to health gaming applications. Outside of WPI, however, there are several organizations that support research into gaming applications designed to be health oriented. One such organization is the Robert Wood Johnson Foundation, or RWJF. RWJF, in 2004, found the Games for Health Project, which supports and provides for research for the development of games and applications designed to improve health and health care. The project holds an annual Games for Health Conference where the currently leading researchers, developers, and companies in health gaming technologies gather to talk about the field. Some notable guests in the past have been developers from Nintendo, TEDMED, the American Heart Association, and Lucasfilm. The project also releases a journal corresponding to the research revealed in the conferences.

In one study, published by SAGE Publications as part of the RWJF, the use of active video games for physical activity promotion was investigated.[xxx] The study involved 28 laboratory studies and 13 intervention studies based on physical video games from between 1995 and 2011, and used 8 to 100 participants. The laboratory studies proved that active video games from this time did result in anywhere from light to moderate levels of physical activity, but only 3 of the thirteen intervention studies showed a significant increase in physical activity.

In another study, published by the nature Publishing Group with support from the RWJF, researchers investigated adolescent exergame play for weight loss and psychosocial improvement.[xxxi] The study examined the user of exergames to support fitness and reduce obesity rates for specifically adolescents. The subjects were gathered from an urban high school, with 54 African American students from 15 to 19 years of age participating, all having a BMI of over the 75th percentile (overweight). The participants would play a competitive exergame, a cooperative one, or neither as part of a control group. The gaming subjects were asked to play an exergame for 30 to 60 minutes each weekday using features from the Nintendo Wii. 73% remained in the study for 10 weeks, dropping to 54% for the complete 20 weeks. The study found that, by playing a cooperative exergame with a friend, a much more significant weight loss was noted than in the

control group. This was an average of 1.65 kg ~ 3.63 lbs, with a standard deviation of 4.5. They also found that, psychologically, cooperative exergaming increased self-efficacy, or self-esteem, much more than those that didn't play. Both the competitive games and cooperative games supported general peer support and friendliness as well.

In a study published by Elsevier, with authors Anderson-Hanley C, Arciero PJ, Brickman AM, Nimon JP, Okuma N, Westen SC, Merz ME, Pence BD, Woods JA, Kramer AF, and Zimmerman EA exergaming and its effect on older adult cognition were investigated.[xxxii] The study notes that physical exercise can prevent and fight dementia, but that older adults face movement as a challenge. The study turned to exergaming in order to encourage older people to move. The study, known as the Cybercycle study, was a clinical trial that compared the effects of using interactive exercycles as opposed to regular stationary cycles. 102 participants were gathered from different living facilities across different sites, where 79 were randomized and 63 members fully completed the trials. Both the interactive and non-interactive cycles were nearly identical, and participants were taught how to monitor their exercise and work towards a target heart rate. Those who rode the 'cybercycle' traversed through a 3D virtual reality, touring natural environments, and they competed against their previous records. Cognitive tests were performed on the subjects, once before cybercycling, and once after three months of cybercycling. It was found that the participants who biked through the virtual reality landscapes received much improved executive functioning than those who simply rode the bike without the 3D environment.

Writer Susannah Fox provides vital statistics regarding health along with mobile and internet usage.[xxxiii] Fox provides updates to these statistics as often as she can on her web page, but described next is data collected as of November 2013. According to the author's research, 85% of adults use the internet, 91% own a cell phone, and 56% own a smart phone. 31% of all cell phone users, with 52% being smartphone users, have used their phone in order to look up their health or medical information of interest, and 19% of all smartphone owners have downloaded a fitness application. This suggests that users indeed demand fitness applications. These stats indicate that fitness applications should strive to be referenced in health articles, so that the larger audience of mobile health researchers can pick up on the available health games for their device. In terms of tracking, 60% of all US adults track their weight, diet, exercise routines, or other fitness data. 33% of all adults track other symptoms, such as blood sugar, pressure, frequent headaches or general sleep patterns. 12% track another individual’s reading besides themselves. These numbers total to 70% of US adults tracking at least one figure of health. Of these health trackers, 49% keep their data in their mind, 34% use paper or physical material, and 21% use technology. Of these 21% technology trackers, 8% use a medical device, such as a glucose meter for blood sugar, 7% use an app on

their phone, 5% use a spreadsheet, and 1% uses other online software. This suggests that users are almost just as inclined to use a phone to track health as a medical device, and that probably due to their convenience more people use a phone to track health than a digital spreadsheet or other tools. Health games could offer more options for tracking and improving a user's physical condition, thus opening themselves as an option for these adults.

With older adults, 75% of those aged 65 or above and 60% aged from 50-64 have a chronic health condition. 54% of adults 65 and up, and 77% of those 50-64 years old use the internet. About 12% of adults over 65 and 32% from 50-64 do own a smartphone. This suggests that older adults could benefit from fitness applications and should be targeted.

2.3.3 Effectiveness of Health Games

The effectiveness of health games and exergames on an individual is a question of study by several researchers. According to Stephen Yang of ExerGame Lab, most studies reveal that exergames only provide a light-to-moderate amount of exercise, and that more engaging exercise is required[xxxiv]. Along with this, they found that after an individual plays an exergame, they tend to relax and perform much less physical routines than those that play standard video games. This suggests that, while exergames can be useful, their effects are often overestimated.

A group of researchers, namely Maddison R, Mhurchu CN, Jull A, Prapavessis H, Foley LS, and Jiang Y, in a study published by the International Journal of Behavioral Nutrition and Physical Activity studied the effectiveness of active video games, specifically on a player's body mass index[xxxv],[xxxvi]. A trial was conducted using 322 children between 10-14 years of age, who were obese. The study used the EyeToy device, and the children played EyeToy Kinetic, EyeToy Sport, and Dance Factory. Their BMI was recorded before the trials began, and 24 weeks after. The researchers concluded that the children achieved a reduced BMI, but their physical activity levels remained the same. Since the children achieved an adequate level of aerobic fitness, however, the exergames proved effective. There was some concern that a device, an accelerometer epoch, was not effective in recording the physical levels of the participants.

In another study by pediatricobesity, with researchers C. O'Donovan, E. F Roche, and J. Hussey, the energy expended by playing active video games in children with obesity versus healthy weight was tested[xxxvii],[xxxviii]. The study used the Nintendo Wii console and Fit board, and participants played Wii Fit Free Jogging and Wii Sports Boxing. At the end of the study, light-to-moderate physical activity

was noted. In general, those who were obese used much less energy than those who were healthy. The differences between the two games were negligible. Overall, the researchers found that exergames can help improve energy expenditure, either by replacing non-physical activities or by working to achieve a moderate workout. The physical fitness of a user and mindset when playing games greatly affects their results, however, as noted by the difference in those who were obese compared to lean.

2.4 Video Game Reviewing and Metrics

2.4.1 Subjective Reviews

As the video game industry is a large media industry, many reviews have been made in order to provide the public with critiques of games. However, what separates a good review from a poor one is rather subjective. Many video game sites and magazines have their own methods for writing a review for a game. In this case, it is best to get the opinions of those with a good grasp in the industry.

Stephen Totilo, the editor-in-chief for the popular video game site Kotaku, believes in a few sturdy rules for separating a good game and a bad one[xxxix]. He believes that, regardless of the genre of a video game, a good video game will offer the player a set of interesting choices to make, and a bad video will offer bland or few choices. He discusses the company Zynga, a company that has produced games such as such as Farmville. He notes that those games were only popular due to rewards, but not by player choices. This eventually led Zynga into a rapid business decline.[xl] Totilo was frequently disappointed through the series of 'Ville' games produced by Zynga, but eventually he tried Adventure World. This game sparked some interest in him, as he was immediately presented with game choices and risks. He also brings up Tetris, a very popular game with historic origins in Russia. It's a rather simple puzzle game, but it remains successful in continual remakes. What keeps the game interesting is the constant need to make decisions. The placement of the block, the rotation of the block, and what piece will come next needs to be taken into consideration every few seconds. A choice needs to be made if the player wants to achieve a higher score by getting a combo through filling a layer of blocks, or if the player simply needs to clear a layer.

Totilo later talks about e-mails from some of the top video game creators he contacted. Dylan Cuthbert, a developer who has worked for Nintendo at their headquarters in Kyoto, weighed in his thoughts. He believed a game should contain a combination of aesthetics, polish, engagement, originality, and 'Merihari,' a Japanese word for a combination of rhythm, balance, and distribution, roughly speaking. A game should keep a good rhythm of gameplay in a level, with a balance in

difficulty, followed by different distributions in challenges, such as boss fights. A game designer and CEO of Gamelab also replied to Totilo. He believes that the game designer must create criteria for success, with a variety of goals. For example, Zynga provides Totilo the feeling that their goal is to simply make money, as every instance he completes a decision, an offer to make an in-game purchase pops up. A video game not only needs decisions, but decisions that make the player feel good and positive.

2.4.2 Metrics

Despite the subjectivity in distinguishing great video games from poor ones, companies will use a set of pure data metrics to determine the success of a game. These metrics can be retrieved either through programming within the game, or by case studies.

G3zar Studios, a mobile indie game development team, provides their essential list for information. The first piece of data they track is the number of game starts. This lets developers know how often a user is returning to play their game. Another piece of data they track is the device type. Differences across the number of devices used may suggest a problem with the version of the game, or potentially problems with the device or device audience themselves. G3zar Studios developed a free version of their main application, Block Blasters, and included a tracker for the number of times a purchase was made, when customer feedback was sent, and when friends were notified of the game. Their next metric is player performance. As games vary, the way to determine a player's performance will greatly change. G3zar's Block Blasters featured a variety of levels and difficulties. To keep track of player performance, they recorded how often a game was started, how many times they won with the amount of stars earned, and the number of times they lost. This information is essential in improving, balancing, and fixing gameplay. Their last metric is playtime. This information should allow one to determine how much time a player spent in a game before ending it. In Android and iPhone games, however, the user may switch to other applications while the game continues to run. This causes issues in timing.

3. Methodology

3.1 Finding and Reviewing Health Games - Procedures

Since the end goal of our project was to have test subjects play a select amount of games in order to get a sense of what types of mobile gaming health apps provide the most effective workout while containing a large degree of entertainment, we first needed to evaluate the applications that are available to the public on the iOS and Android marketplaces. In order to do this, several things were be done first: 1.) Determining the protocols for searching and finding games on Android and iOS marketplaces and 2.) Determining what a "game" actually is, compared to the other types of applications that could be used by smartphone owners.

1.) Protocol for searching health gaming iOS apps in Apple's App Store:

The App store on the Apple iPhone is a repository for all iPhone applications. After opening the App Store on ones iPhone, we used the "Search" function to find our apps. Although Apple conveniently provides many categories to browse apps in, there was no specific category that fit our needs. The "Health and Fitness" category has no way to narrow the apps down to only games, and the "Games" category, while having many subgenres, has none for gaming or fitness apps. Due to this fact, we had to do our own search. For our search we used two different groups of keywords to find our apps. The first group was a search using "health games," and the second was a search using the key words "fitness games." The search of "health games" on the app store results in 552 hits, while "fitness games" results in 386 hits. These numbers are as of November, 2013. Different numbers might be obtained at later times due to changes in the app store.

2.) Protocol for searching for health gaming Android apps on the Google Play store:

Google Play is an app that can be used to search the Android app market, a repository for all Android applications. After opening the Google Play store on an Android, we searched for games in the category of "Health and Fitness". This category contained two subcategories. One subcategory was Paid, and the other was Free. We investigated games from both of these subcategories. There were approximately 620 apps in the Paid subcategory and there are approximately 560 in the free category as

of November, 2013. Similar to the issue found in the iOS category of "Health and Fitness" apps, many of these apps are not games. As a result, we needed to provide specific key terms to gather a more accurate query. The terms we used were: Health games, Fitness games, Exergames, Location Based games, and Augmented Reality. Unfortunately, searching with key terms removes the category of "Health and Fitness," and queries the entire app store.

3.) Determining apps with Gaming components:

Now that we have our apps, we must determine which ones are actually games, and which ones are not (tracking apps, diet apps, etc.). For this project we have defined several elements that a game must possess:

a. There is a competitive aspect to the game (leaderboards, statistics, etc.).
b. There is a story that the players can progress through as they play the game. There needs to be a clear purpose to the game. The player can progress through a storyline or play to complete predefined challenges or goals.
c. There is a social aspect which allows interacting with other players or friends.

An app needs to have both the "a" and "b" components for it to be considered a game. The final component "c" is optional for a game. Applying these decision rules allowed us to separate non-game apps from other health and fitness apps and narrow down our previous searches to a smaller list composed of only health and fitness apps with gaming components.

After we were left with only gaming apps, we took the top games based on popularity and review them. Popularity was based on high ratings and the number of downloads. Two members of our project team that are Android users reviewed games from the Android Store and one team member who was an iPhone user reviewed games from the App Store. Reviewers used our review criteria to conduct their assessments. After the games were reviewed, we took each individual's top ten games and looked for overlap and had other members of the group look at the games. Finally we reached a decision of which games were the best and came up with our top ten overall games from the entire group for each platform. These twenty games, ten from Android and ten from iPhone, were the base for our human testing.

At the end of our application selection, we had fewer games than we had originally hoped. As a result, there were fewer games available for study participants. 45 participants would be a sufficient quantity to test all of these applications, but we still hoped to gather 60 for thoroughness.

Free Android (Survey)	Paid Android	Free iPhone (Survey)	Paid iPhone
StreetQuest	Zombies, Run!	Ninja Fitness Free	CodeRunner
Tourality	Ghostbusters: Paranormal Blast	Teemo	FitQuest
Nexercise	Geocaching	Healthy Heroes	
Ingress	SpecTrek	FitQuest Lite	
SpecTrek Light	Couch-to-5k	Nexercise	
Fitocracy		Charity Miles*	
SCVNGR			
Charity Miles*			

*Table 1: *Charity Games utilizes charity sponsors as opposed to game play to motivate users. We were interested to see its effectiveness is in this regard.*

4. Review Criteria:

Our review criteria are: entertainment value, interactivity/immersion, ease of use, replay value, physical effectiveness, and then the final overall rating of the game. Each review component was broken down into several key aspects. These aspects were then ranked on a 1-to-5 scale, where 1 represents Strongly Disagree, a 2 represents Disagree, a 3 represents Neutral, a 4 represents Agree, and a 5 represents Strongly Agree. An example of what this looked like on our surveys can be seen below. These were tabulated into a numeric score. For a rough summary of a game, our reviews featured a table with the average scores and short comments.

Games	Device	Game Location	Price	# Downloads	Free Option	Avg. Rating	# Reviews	Key Notes / Target Audience
Sample_Game_1	Android	Android Marketplace	$1.00	5000	✔	4.2	30	Game has night mode Aimed toward those with Free time at night

Table 2: Sample List of all games to be reviewed

	Sample_Game_1	
Criteria	Score (Out of 5)	Comments
Entertainment Value	4	Fun to run at night
Interactivity	4	Keeps player on their toes
Ease of Use	2	Messy and confusing overlay
Replay Value	3	Missions become somewhat repetitive
Physical Effectiveness	3	Requires a decent amount of running
Overall	3.2	Worth playing a few times

Table 3: Sample Table of a Review of a Game

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5
☐	☐	☐	☐	☐

Table 4: Sample Table for a Survey Response

Game Name	Game Genre	Description
StreetQuest	Location-Based Runner, Game	A fitness application that provides unique games for running (running away from monsters, collecting stars) and features multiplayer challenges along with social networking
Tourality	Location-Based Runner, Game	A scavenger-type game with single player and multiplayer challenges, and supports teamplay. Challenges include racing to locations in a lap, following a trail, chasing and marking spots, and rushing any spot.
Nexercise	Workout	A workout application that contains a strong list of running and other exercising activities. Features include a built-in social network, activity history and statistics, and medals.
Ingress	Augmented Reality, Location-Based Game	A science-fiction game featuring two opposing factions. The factions, either the Enlightened or the Resistance, compete against each other to claim Portals, which are at certain locations. Portals can be protected and attacked.
SpecTrek (Light)	Augmented Reality, Location-Based Game	A ghost hunting game where ghosts appear in a certain radius. Players must quickly find the ghosts on their map, and then use their phone to view it and capture it.
Fitocracy	Workout	A workout application with a built-in social network. Features a tracking system with levels and quests. Quests are types of exercise activities, and they become more difficult as the user gains levels.
SCVNGR	Location-Based Game	A location based app that provides badges and rewards for checking into or doing a challenge certain locations. Challenges are simple such as sending a message or photo while at the location. Features a built-in social network with a social map.
Charity Miles	Runner	A running application used to provide corporate sponsorship and support for charities. The user selects a charity to support and simply runs.
Zombies, Run!	Runner	A running application that uses story telling as motivation for running. The stories are horror-themed and involve escaping zombies. Statistics are tracked while running.
Ghostbusters: Paranormal Blast	Augmented Reality Game	A ghost hunting game with features from the Ghostbuster movies. Players must hold ghosts with a proton pack, and then capture them into a ghost trap. Features a variety of missions and enemies, along with upgrades and rewards.
Geocaching	Location-Based Game	A scavenger-type game where players must seek out and hide containers called ‘geocaches.’ The geocaches are real world containers that may contain a variety of trinkets left from other people.
Couch-to-5k	Runner	A running application that utilizes 4 choices of cartoon-coaches to help the user run. Statistics are tracked during running, and the trainers provide helpful tips in the form of human-audio as

		the user runs.
Ninja Fitness	Workout	A workout application that involves a variety of workouts, such as pushups and crunches, in order to level up and improve a 3D ninja. By working out the user gains ninja stars which can be used for unlocking outfits. Different workouts increase one of four skills: strength, agility, endurance, and zen. By leveling each skill up the user can unlock ninja belts.
Teemo	Workout	A workout application that features a variety of challenges for getting fit. Challenges have themes such as climbing Mt. Everest or running through a desert. Statistics are tracked with a meter showing how much endurance, strength, and wellness was achieved, and rewards can be unlocked for accomplishing certain challenges.
Healthy Heroes	Educational Game	An educational health game targeted for young gamers. Feature a variety of characters named 'Yogotars' and the user must feed different monsters healthy foods. There are also tips for improved diets.
FitQuest (Lite)	Workout	A workout game where the user must jog, hop, duck, or do other movements in place in order to get a baby squirrel to its tree house.
CodeRunner	Augmented Reality, Location-Based Game	A virtual game where the user acts as a spy, going to locations to see simulated game characters and to 'hack' into networks. 'Dead drops' can be created by users, to hide virtual items for others to grab.

Table 5:List of games with details

We shall now describe our review criteria in some detail, based upon the research on the gaming site *Kotaku*:

Entertainment Value: This is based highly on how much we enjoyed the game, judging it more on a creative level. The measures for this construct are:

1.) The game offers a compelling storyline.
2.) The game has original art, such as models, sounds, and/or designs.
3.) The game offers multiple challenges.
4.) Each challenge in the game requires unique approaches. For example an approach may be to run away from a monster, run on a certain path, or catch a bunny.

Interactivity/Immersion: This field measures how much a game incorporates the player's actions:

1.) There is a clear objective to for the player to accomplish.
2.) The players exercise at a certain pace, or reach different areas, in order to achieve their goal.

The following questions did not use the review scale, but instead were answered in a factual manner to better understand the reviewer's opinions of the game:

Ease of Use: This section describes how simple it is to download, launch, and play a game. Examples of responses to this section could be:

1.) I found it easy to begin using this game.
2.) I was able to learn game mechanics and controls quickly and with little trouble or effort.
3.) I found this game easy to understand.
4.) I found this game easy to navigate.

Replay Value: This section examines how much a player will be driven to return to a game after playing it for some time. Examples of responses to this section could be:

1.) The fact that I can move onto a new level motivates me to play this game again.
2.) Posting my results on social networks motivates me to play this game again.
3.) The changes in the game as I progress motivate me to play this game again.

Physical Effectiveness: This investigates how effective the game is at providing a good physical workout. Examples of responses to this section could be

1.) The game has me exercise at a constant rate that I can set to fit my physical demands.
2.) I find the stats the game keeps about my progress helpful.
3.) I have seen noticeable improvements in my physical health since I started playing this game.
4.) This game is effective in establishing my regular physical activity.

Overall: For a user to generate their overall score, the average of the five previous review guidelines was averaged. After this value was obtained and the user had settled on the game's final overall score, they were asked to comment generally on their experience of their time with the game, perhaps expanding further on some comments made in earlier guidelines. This section should surmount to a summary of the previous guidelines, giving a general pros and cons of the game to simplify the review.

3.2 User Study

3.2.1 Motivation to Conduct a User Study

In order to better investigate and determine how future health games should be designed in order to achieve a larger audience of health game players while promoting general health and exercise, we needed more than the reviews of our group. We gathered the opinions of a general user group.

3.2.2 Study and Data Collection

In order to achieve this objective, we required owners of Android-based smart phones and iPhones to play a variety of games. Users were not supplied with a phone and had to own either smartphone to participate. We had 8 Android games and 6 iPhone games for participants to play. To tabulate a strong set of results, we asked each participant to play 3 games, submitting a review form for each. We needed 60 participants to partake in this study. Participants were asked to attend a session in a library tech suite, where they were instructed on how to download and play their designated health gaming applications. Free pizza was available in each session. Only after each game has been played for some time over the course of three days should they then complete our standard questionnaire, along with a few questions. This resulted in a total of nine days for the entire study at the longest for each individual. Users played the games for three days in order to get a better understanding of the game and learn its mechanics more thoroughly, resulting in better survey results. This survey was available online through Qualtrics software. These questions asked about their thoughts and opinions of the game. We asked for ideas for how future health game applications should be developed. Participants were met in person to conduct interviews verbally, with the information recorded by pen and paper, either in a public or private area. Additionally, a list of participant's emails was created in order to keep track of those participating in the study.

Subjects needed to take into consideration the same risks and discomforts that any other Android or iPhone owner using their cell phone outside would need to take. These games were publicly available and there were no additional risks associated with this study. Subjects with preexisting medical conditions or those who were not accustomed to physical activity were advised not to partake in this study, as it would require physical exertion. Subjects were notified of these details before beginning the study.

Interviews and questionnaire forms were secured by our IQP team, until all information was uploaded digitally, and the rest destroyed. The digital information will be kept in WPI's secure servers for 3 years. The information gathered will remain confidential, even within the report. No subjects were identified by name and all statistics were reported in aggregate form only.

From this study, subjects did not directly receive compensation from us, but may have noticed an improved quality of health, and they were allowed to keep any application they downloaded as part of this study. Reviews were publicly available for potential use by mobile application developers, in

order to better create a new health game, or for smart phone users hoping to find a health game that works for them.

3.2.3 Subject Recruitment

3.2.3.1 E-Mail

To supplement our request for study participants from SONA, we issued an e-mail to WPI students asking them to participate in our study. Students of all year levels and majors were qualified to perform this study and received the following e-mail. Below is an example of the e-mail:

Hello WPI Community,

We are an IQP group assessing the current situation of health gaming apps for mobile smart phones, more specifically iPhones and Android phones. We are looking for volunteers to test several games so that we can generate real world feedback about the pros and cons of these games in hope to discover what makes an effective mobile health game. The testing will involve the use of games for a few days, up to a week, and will require a certain level of physical exercise as determined by each game.

If you are interested, please reply to this email with the topic "Assessment of Mobile Fitness Games" for more information. Please include your major and class year as well. Additionally, if you would like, we will be holding an information session (with pizza!) in a library tech suite (room, date, and time TBA) where we will help you

download/set up the games, as well as provide instructions in person.

Sincerely,

Members of the Health Gaming IQP Group

3.2.3.2 Campus Table

As we spread awareness of our study through e-mails, we also held a table at the WPI Campus Center. We used a poster board, featuring relevant project information as well as interesting game art. Flyers were handed out with information on the study and the group's contact information for students who became interested in the project.

3.2.3.3 Qualtrics Survey Template

A link to a template of the online survey can be found here:
https://wpi.qualtrics.com/SE/?SID=SV_1GtPJ2uRwp3uh9j&Preview=Survey&BrandID=wpi
(Note: This is not the actual Assessment of Mobile Fitness Games survey. Responses here were ignored.)

4. Results

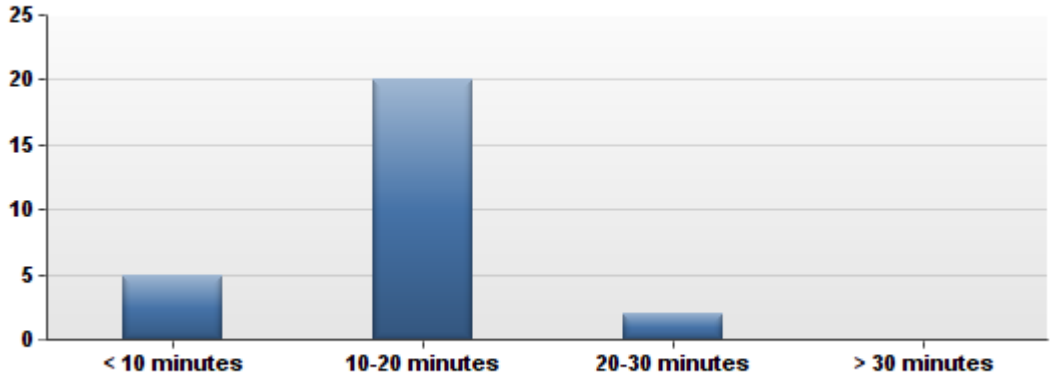
This chapter covers the results of the user study (Qualtrics Survey).

4.1 Demographics

“Which game are you responding to (Question 5)?”
We were unable to assign Charity Miles to any Android users because it requires a Droid 3 or higher.

#	Answer		Response	%
1	StreetQuest (Android)		2	7%
2	Tourality (Android)		2	7%
3	Nexercise (Android)		1	4%
4	Ingress (Android)		1	4%
5	SpecTrek Light (Android)		1	4%
6	Fitrocracy (Android)		1	4%
7	SCVNGR (Android)		3	11%
8	Charity Miles (Android)		0	0%
9	NF Free (iPhone)		4	14%
10	Teemo (iPhone)		2	7%
11	Healthy Heros (iPhone)		3	11%
12	FitQuest Lite (iPhone)		3	11%
13	Nexercise (iPhone)		2	7%
14	Charity Miles (iPhone)		3	11%
	Total		28	100%

“On average, how long did you play the game each time (Question 25)?”
Subjects were encouraged to play as long as they could. The study was conducted during the winter season which may have reduced the length of time participants played the games. We speculate that the reported average times played per game may have been longer in warmer weather.



#	Answer		Response	%
1	< 10 minutes		5	19%
2	10-20 minutes		20	74%
3	20-30 minutes		2	7%
4	> 30 minutes		0	0%
	Total		27	100%

Statistic	Value
Min Value	1
Max Value	3
Mean	1.89
Variance	0.26
Standard Deviation	0.51
Total Responses	27

“How many years have you owned a smart phone (Question 38)?”

#	Answer		Response	%
1	1-2 years		14	54%
2	3-4 years		12	46%
3	>5 years		0	0%
	Total		26	100%

Subjects were relatively new to smart phones. We neglected to add in an answer for less than a year. Answers for response #1 should more accurately be read as 0-2 years.

“What is your age (Question 34)?”

#	Answer		Response	%
1	18-20		16	59%
2	21-25		11	41%
3	26-30		0	0%
4	31-35		0	0%
5	36-40		0	0%
6	>40		0	0%
	Total		27	100%

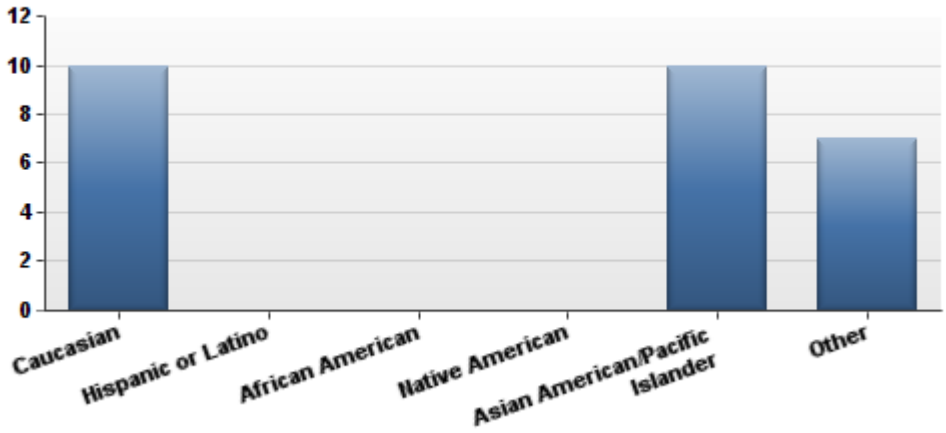
“What is your gender (Question 35)?”

#	Answer		Response	%
1	Male		14	52%
2	Female		13	48%
3	Other		0	0%
	Total		27	100%

“How did you find out about this study (Question 40)?”
Most of the subjects were SONA participants, who receive course credit for participating in studies.

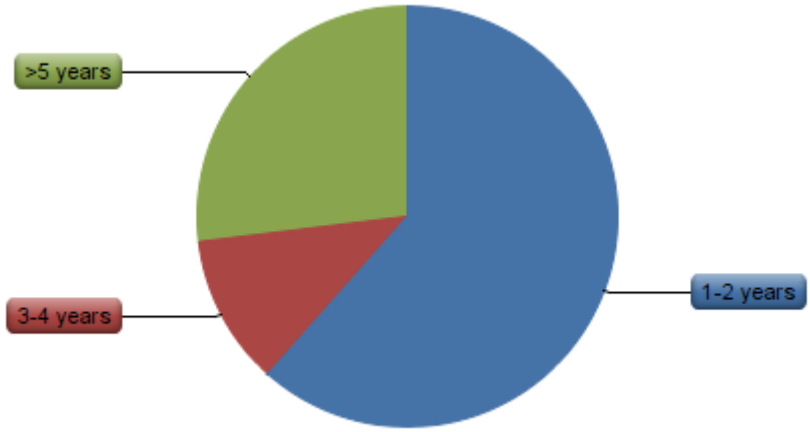
#	Answer		Response	%
1	E-Mail		0	0%
2	SONA		20	74%
3	Campus Center Table		0	0%
4	Flyer		0	0%
5	Word of Mouth		1	4%
6	Other		6	22%
	Total		27	100%

“What background or ethnicity do you identify with (Question 36)?”
Our subjects were primarily Caucasian and Asian American/Pacific Islander. Two subjects classified themselves as other.



#	Answer		Response	%
1	Caucasian		10	37%
2	Hispanic or Latino		0	0%
3	African American		0	0%
4	Native American		0	0%
5	Asian American/Pacific Islander		10	37%
6	Other		7	26%
	Total		27	100%

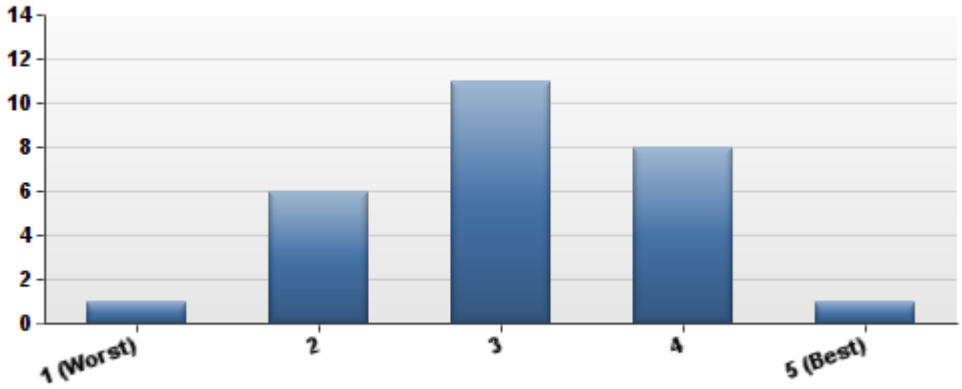
“How many years have you played mobile games (Question 37)?”
Most subjects were new to mobile games. We neglected to add in an answer for less than a year. Answers for response #1 should more accurately be read as 0-2 years.



#	Answer		Response	%
1	1-2 years		16	62%
2	3-4 years		3	12%
3	>5 years		7	27%
	Total		26	100%

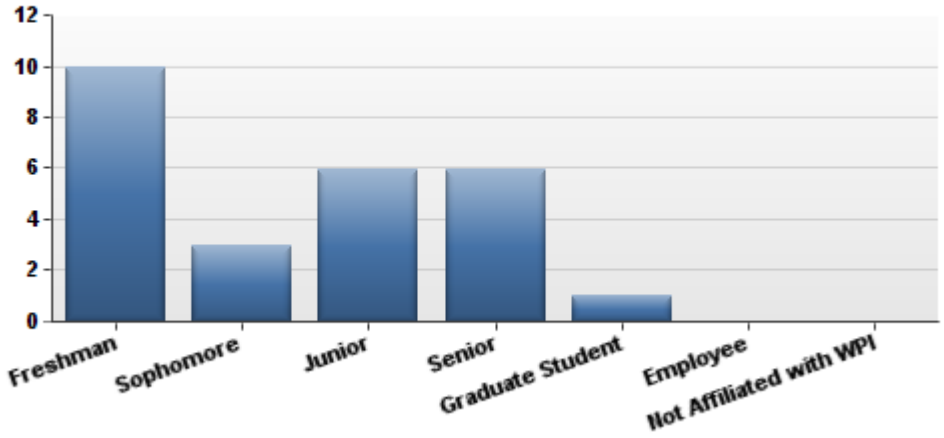
Statistic	Value
Min Value	1
Max Value	3
Mean	1.65
Variance	0.80
Standard Deviation	0.89
Total Responses	26

“What is your overall rating of the game (Question 32)?”
Overall subjects had a neutral mentality toward these games.



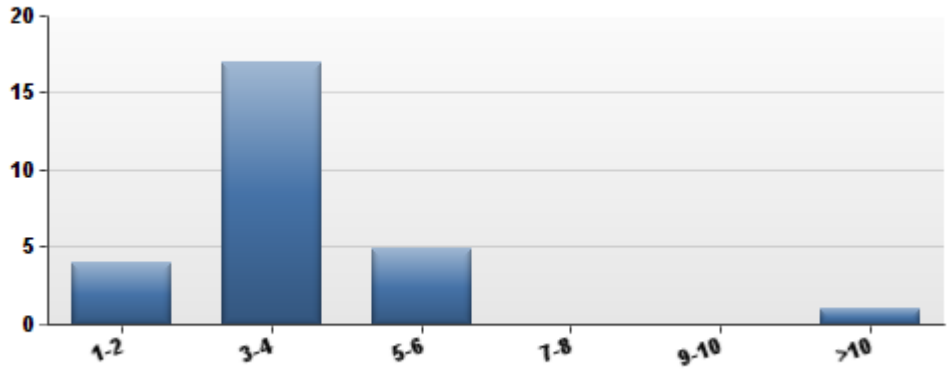
#	Answer		Response	%
1	1 (Worst)		1	4%
2	2		6	22%
3	3		11	41%
4	4		8	30%
5	5 (Best)		1	4%
	Total		27	100%

“What is your affiliation with WPI (Question 39)?”
All subjects were WPI students.



#	Answer		Response	%
1	Freshman		10	38%
2	Sophomore		3	12%
3	Junior		6	23%
4	Senior		6	23%
5	Graduate Student		1	4%
6	Employee		0	0%
7	Not Affiliated with WPI		0	0%
	Total		26	100%

“How many times did you play the game (Question 24)?”
Subjects were asked to play each game at least 3 times. It’s disappointing that a couple of participants didn’t. It is reassuring to see that some participants played the games more than 3 times.



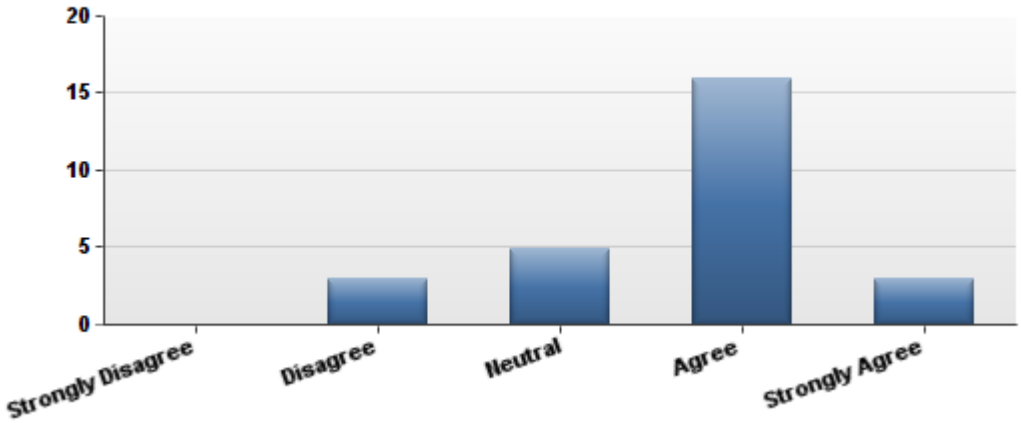
#	Answer		Response	%
1	1-2		4	15%
2	3-4		17	63%
3	5-6		5	19%
4	7-8		0	0%
5	9-10		0	0%
6	>10		1	4%
	Total		27	100%

4.2 User Study Results

4.2.1 Physical Effectiveness

"The physical exertion provided by the game challenged me adequately, but was within my capabilities (Question 20)."

Based on the figure below we speculate that overall these games are capable of getting people to exercise. Of all responses, 70% answered positively, and only 11% answered negatively. This shows a strong consensus that these games provided an adequate workout. All 3 negative responses were from subjects who tested the game FitQuest Lite. We speculate that FitQuest Lite lacks an adequate physical challenge to subjects.



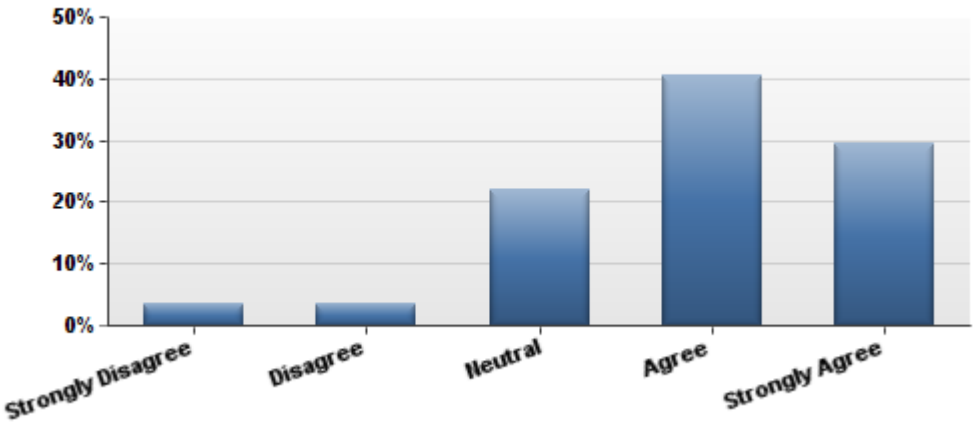
#	Answer		Response	%
1	Strongly Disagree		0	0%
2	Disagree		3	11%
3	Neutral		5	19%
4	Agree		16	59%
5	Strongly Agree		3	11%
	Total		27	100%

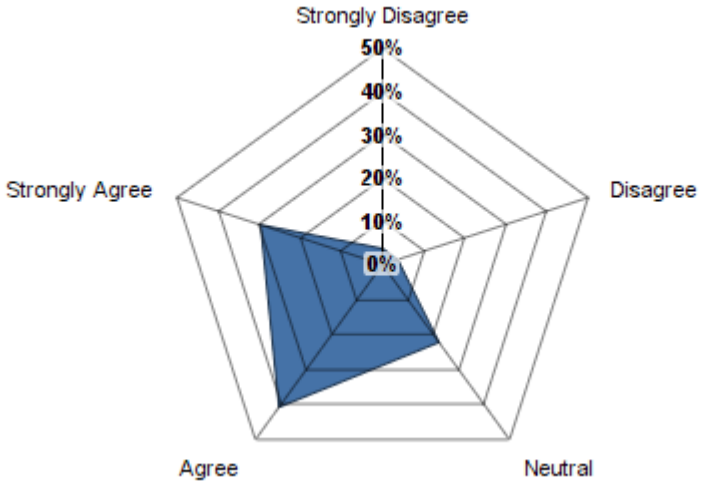
Statistic	Value
Min Value	2
Max Value	5
Mean	3.70
Variance	0.68
Standard Deviation	0.82
Total Responses	27

4.2.2 Ease of Use

“Downloading, launching, and beginning to use the game was simple and straightforward (Question 12).”

Most of the games were manageable to install, setup, and start with 71% of the responses being positive in the figures below. Only two responses indicated any difficulty with starting any game. This was expected as none of the researchers had any issues during game testing.



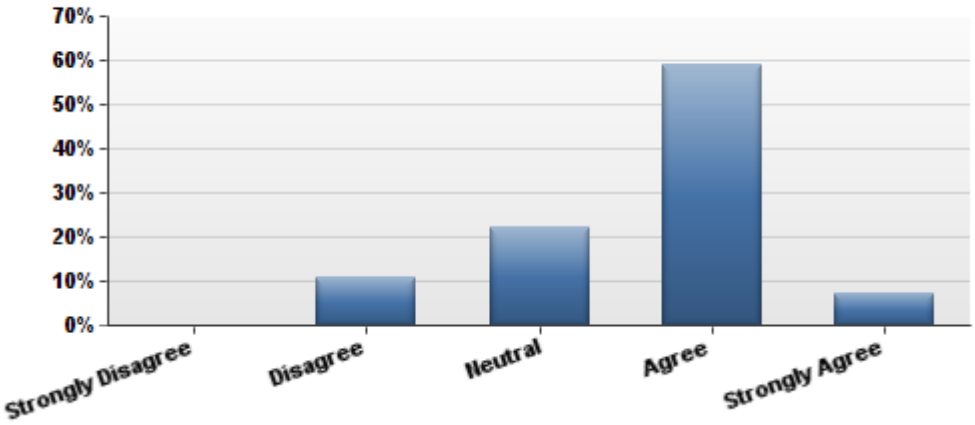


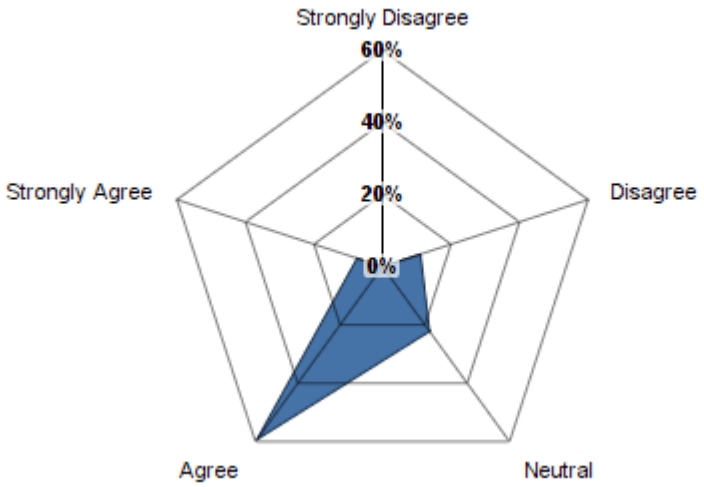
#	Answer		Response	%
1	Strongly Disagree		1	4%
2	Disagree		1	4%
3	Neutral		6	22%
4	Agree		11	41%
5	Strongly Agree		8	30%
	Total		27	100%

Statistic	Value
Min Value	1
Max Value	5
Mean	3.89
Variance	1.03
Standard Deviation	1.01
Total Responses	27

“I found this game's instructions to be relatively easy to understand (Question 15).”

Based on the data below we can speculate that overall the games had clear and simple instructions. Only a mere 11% of the responses were negative in comparison to 66% positive.



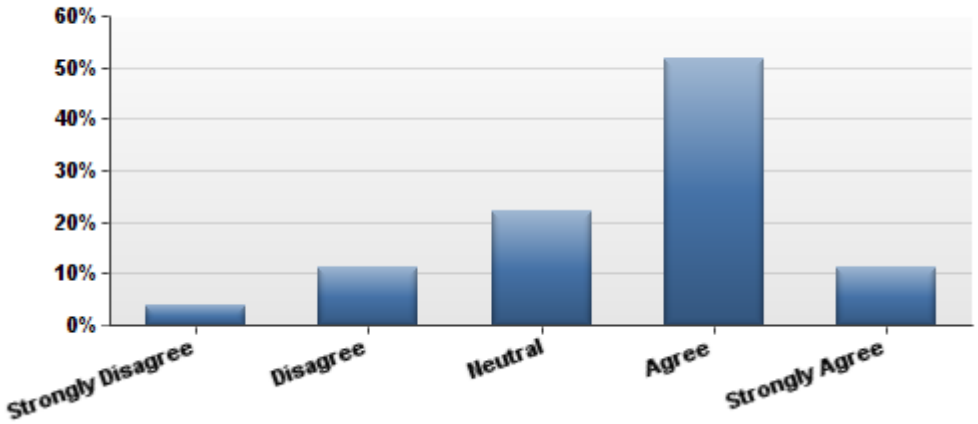


#	Answer		Response	%
1	Strongly Disagree		0	0%
2	Disagree		3	11%
3	Neutral		6	22%
4	Agree		16	59%
5	Strongly Agree		2	7%
	Total		27	100%

Statistic	Value
Min Value	2
Max Value	5
Mean	3.63
Variance	0.63
Standard Deviation	0.79
Total Responses	27

“It was easy to navigate through the game's various menus and options (Question 13).”

According to the figure below, we speculate that these games were simple to use overall. Subjects responded 63% positive to 15% negative.

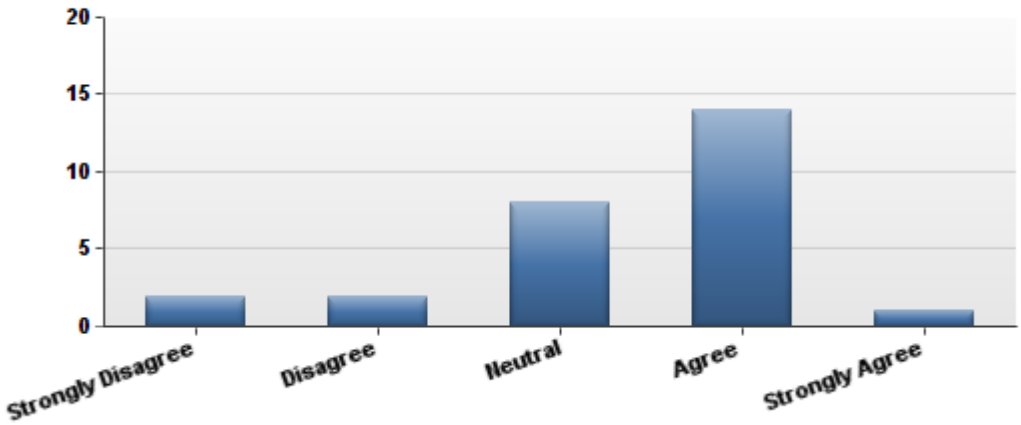


#	Answer		Response	%
1	Strongly Disagree		1	4%
2	Disagree		3	11%
3	Neutral		6	22%
4	Agree		14	52%
5	Strongly Agree		3	11%
	Total		27	100%

Statistic	Value
Min Value	1
Max Value	5
Mean	3.56
Variance	0.95
Standard Deviation	0.97
Total Responses	27

“I was able to learn game mechanics and controls quickly and with little trouble or effort (Question 14).”

Most of the games are relatively straightforward to pick up.



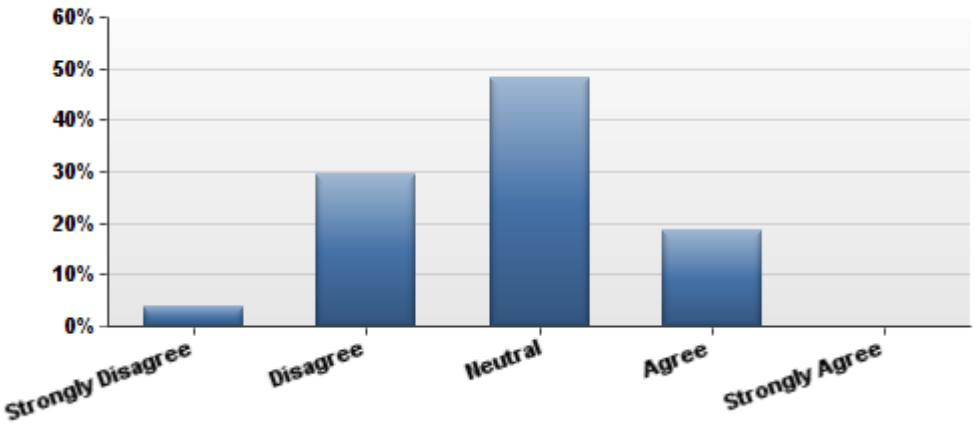
#	Answer		Response	%
1	Strongly Disagree		2	7%
2	Disagree		2	7%
3	Neutral		8	30%
4	Agree		14	52%
5	Strongly Agree		1	4%
	Total		27	100%

Statistic	Value
Min Value	1
Max Value	5
Mean	3.37
Variance	0.93
Standard Deviation	0.97
Total Responses	27

4.2.3 Social Networking

“The game's social networking features are well integrated and motivate me to continue playing this game (Question 17).”

Social networking appears to not play a key role in mobile fitness games. Subjects tested games alone and were never pushed to experiment playing with other subjects. We speculate that users were still learning how to play these games and that our timespan was not adequate enough to give users the chance to experiment with this feature. We would recommend that subjects, in future tests, be given at least four weeks so that they have enough time to become properly acclimated with social networking.



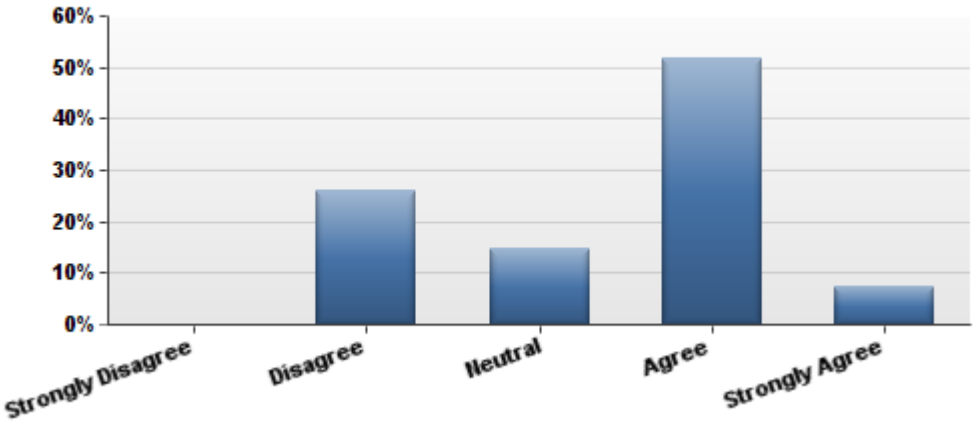
#	Answer		Response	%
1	Strongly Disagree		1	4%
2	Disagree		8	30%
3	Neutral		13	48%
4	Agree		5	19%
5	Strongly Agree		0	0%
	Total		27	100%

Statistic	Value
Min Value	1
Max Value	4
Mean	2.81
Variance	0.62
Standard Deviation	0.79
Total Responses	27

4.2.4 Statistics Tracking

“The game tracks helpful stats that show my physical performance, such as calories burnt or miles ran (Question 21).”

One of the things these games do well is track statistics. These give users helpful bench marks to reach and a good understanding of where they are physically. The figure below reinforces this trend with a majority believing that in game stats are effective.



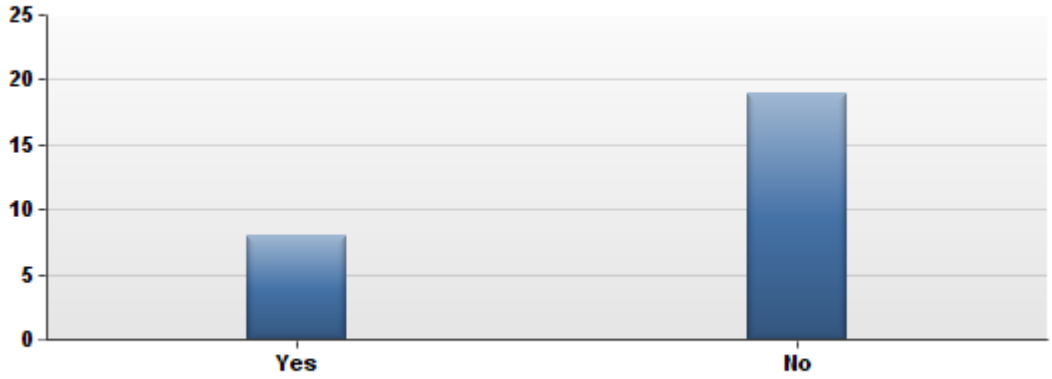
#	Answer		Response	%
1	Strongly Disagree		0	0%
2	Disagree		7	26%
3	Neutral		4	15%
4	Agree		14	52%
5	Strongly Agree		2	7%
	Total		27	100%

Statistic	Value
Min Value	2
Max Value	5
Mean	3.41
Variance	0.94
Standard Deviation	0.97
Total Responses	27

4.2.5 Replay Value

“Do you see yourself playing this in the future (Question 33)?”

The majority of players did not express an interest to replay these games in the future. This could be due to the short amount of time subjects were given to play the games. Many subjects agreed to play for credit. We speculate that the games weren’t fun enough, or required too much work for the subjects’ tastes. Another possibility is that the games provided too little of a challenge, or that the game was overly simplistic.

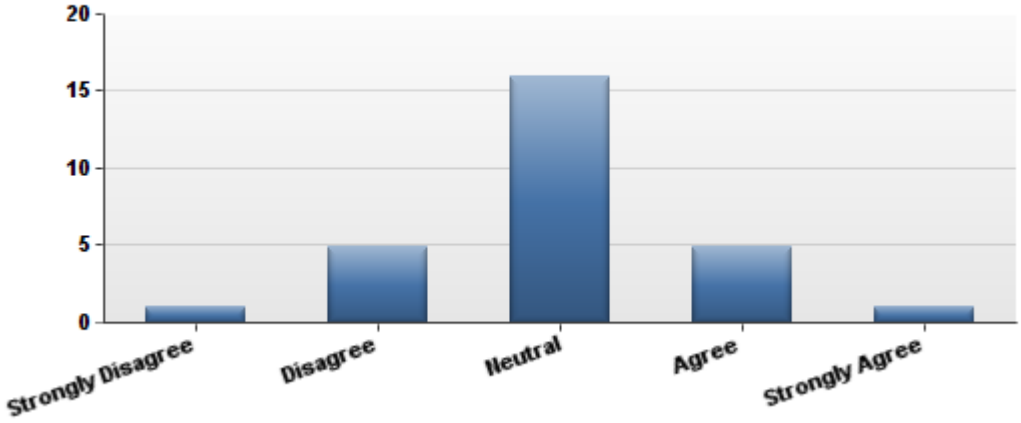


#	Answer		Response	%
1	Yes		8	30%
2	No		19	70%
	Total		27	100%

Statistic	Value
Min Value	1
Max Value	2
Mean	1.70
Variance	0.22
Standard Deviation	0.47
Total Responses	27

“There are other changes, such as unlockable content, that motivate me to continue playing (Question 18).”

Players didn’t get enough time to progress through these games to really form an opinion. We speculate study in which players played for at least a month would enable them to achieve a level of competence necessary to unlock content and generally lead to more meaningful data.

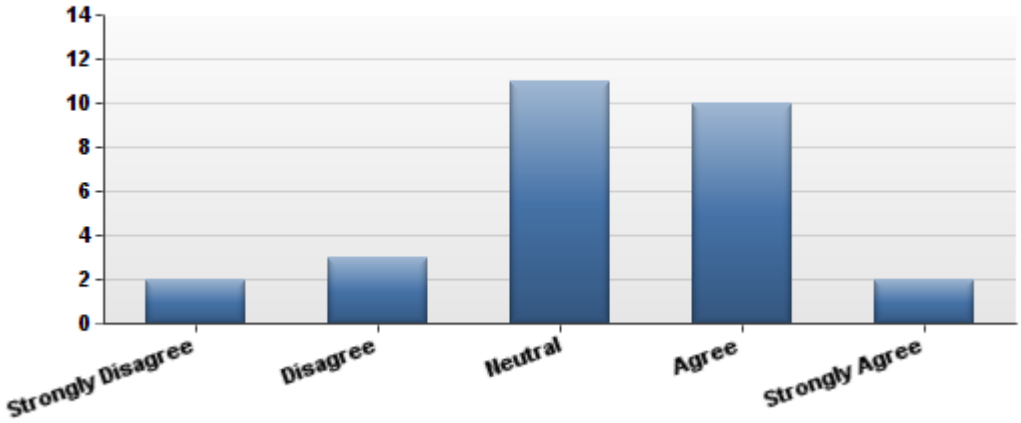


#	Answer		Response	%
1	Strongly Disagree		1	4%
2	Disagree		5	18%
3	Neutral		16	57%
4	Agree		5	18%
5	Strongly Agree		1	4%
	Total		28	100%

Statistic	Value
Min Value	1
Max Value	5
Mean	3.00
Variance	0.67
Standard Deviation	0.82
Total Responses	28

“The game features multiple game levels which motivate me to continue playing (Question 16).”

Responses for this question were relatively diverse; however, a plurality of subjects reacted positively indicating that games integrated multiple levels effectively and that users enjoyed them.



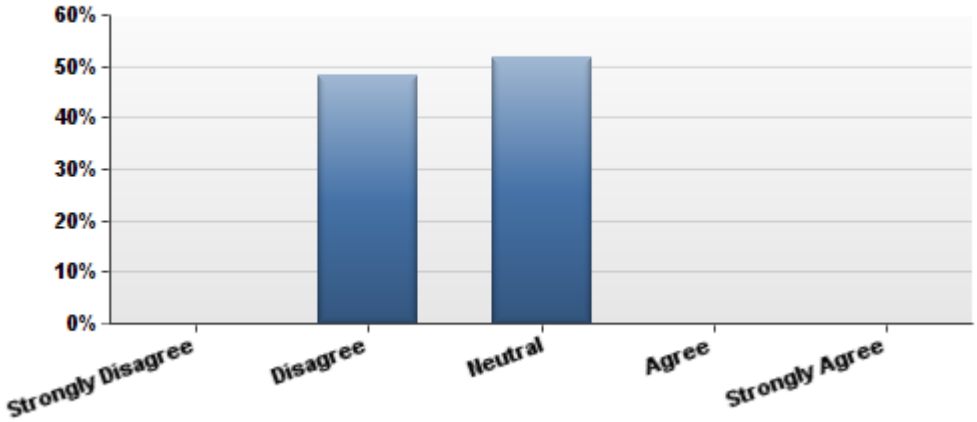
#	Answer		Response	%
1	Strongly Disagree		2	7%
2	Disagree		3	11%
3	Neutral		11	39%
4	Agree		10	36%
5	Strongly Agree		2	7%
	Total		28	100%

Statistic	Value
Min Value	1
Max Value	5
Mean	3.25
Variance	1.01
Standard Deviation	1.00
Total Responses	28

4.2.6 Habitual Effect

"As a result of playing this game, I have seen noticeable improvements in my exercise habits (Question 22)."

We speculate that the test duration was too short for subjects to develop exercise habits. Also prior athletic experience may play a role as it was not addressed in this study. Time of year could play a major role as well. Testing was conducted in the winter. A longer study, conducted during warmer seasons, could potentially yield more favorable results.

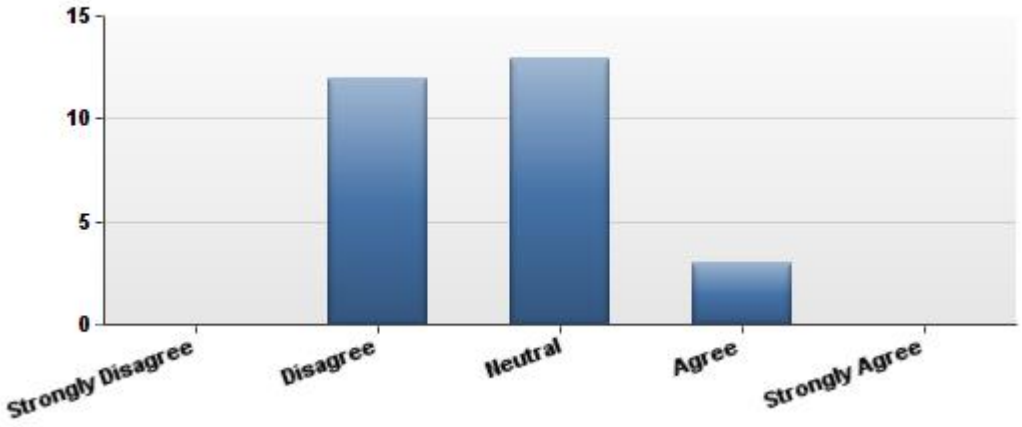


#	Answer		Response	%
1	Strongly Disagree		0	0%
2	Disagree		13	48%
3	Neutral		14	52%
4	Agree		0	0%
5	Strongly Agree		0	0%
	Total		27	100%

Statistic	Value
Min Value	2
Max Value	3
Mean	2.52
Variance	0.26
Standard Deviation	0.51
Total Responses	27

“This game helped me establish a regular exercise schedule (Question 23).”

We speculate subjects weren’t exposed to these games long enough to have an effect on their exercise habits.



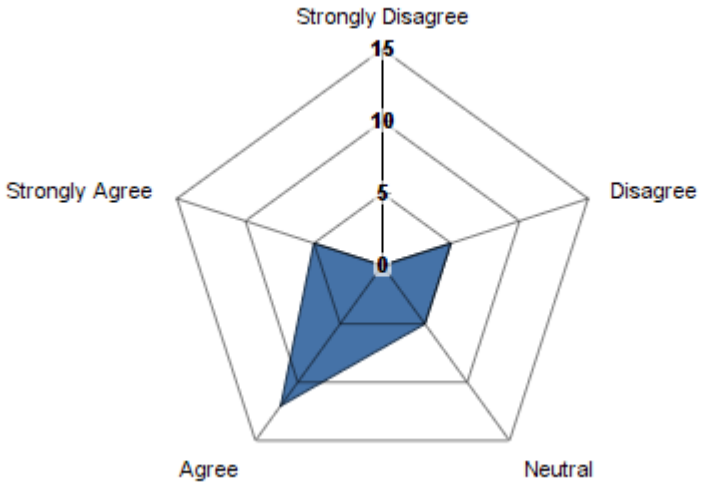
#	Answer		Response	%
1	Strongly Disagree		0	0%
2	Disagree		12	43%
3	Neutral		13	46%
4	Agree		3	11%
5	Strongly Agree		0	0%
	Total		28	100%

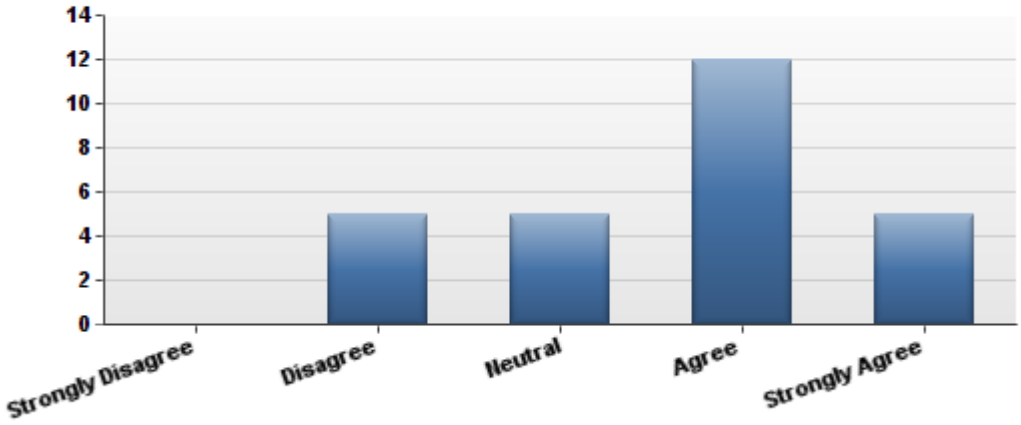
Statistic	Value
Min Value	2
Max Value	4
Mean	2.68
Variance	0.45
Standard Deviation	0.67
Total Responses	28

4.2.7 Interactivity/Immersion

“The game made me move in a variety of ways. I did not simply move in a circle, or straight line (Question 11).”

Overall these games kept subjects doing varied tasks.

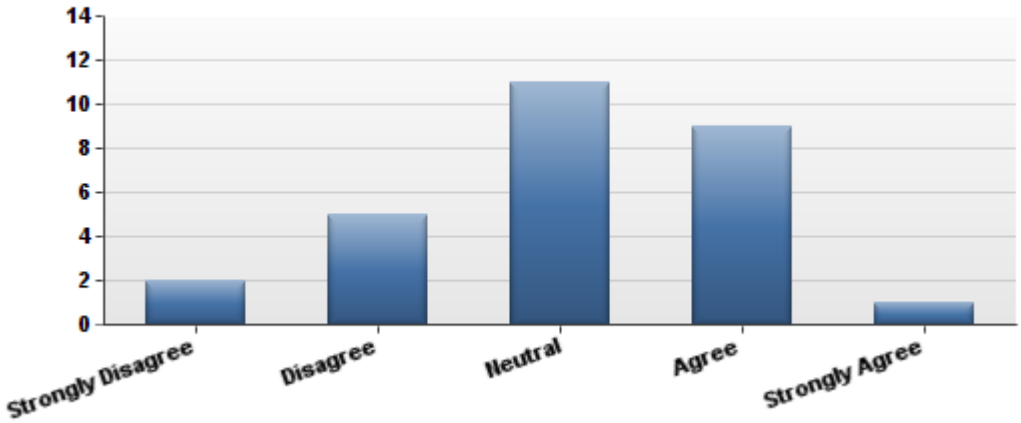




#	Answer		Response	%
1	Strongly Disagree		0	0%
2	Disagree		5	19%
3	Neutral		5	19%
4	Agree		12	44%
5	Strongly Agree		5	19%
	Total		27	100%

Statistic	Value
Min Value	2
Max Value	5
Mean	3.63
Variance	1.01
Standard Deviation	1.01
Total Responses	27

"I felt I had a strong influence on the game. The choices I made greatly affected gameplay outcomes (Question 9)."
Subjects didn't feel that they had a strong impact on the game's outcomes.



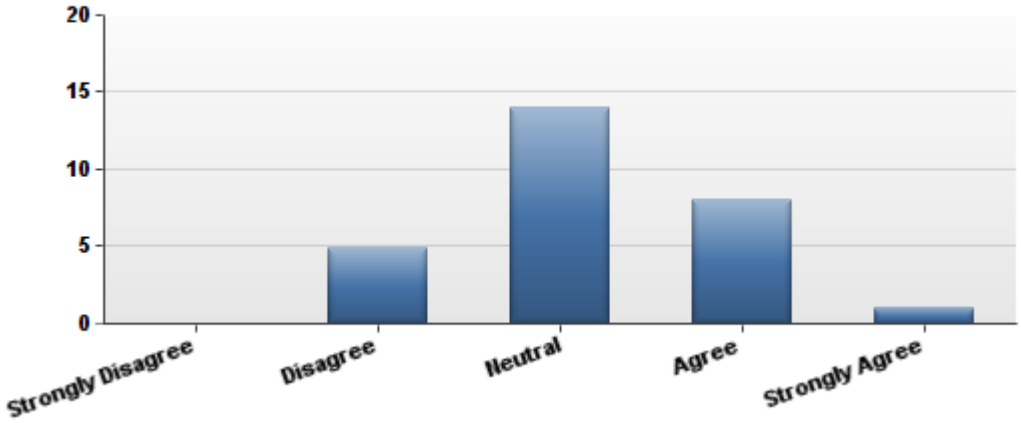
#	Answer		Response	%
1	Strongly Disagree		2	7%
2	Disagree		5	18%
3	Neutral		11	39%
4	Agree		9	32%
5	Strongly Agree		1	4%
	Total		28	100%

Statistic	Value
Min Value	1
Max Value	5
Mean	3.07
Variance	0.96
Standard Deviation	0.98
Total Responses	28

4.2.8 Entertainment Value

“The game was not too linear. I had a large selection of challenges, the same challenges could be played in a variety of orders, and there were multiple ways to achieve my goal (Question10).”

There was no strong consensus. These games are, at their core, health exercising applications. Developers of future games could put much more variety in their games.

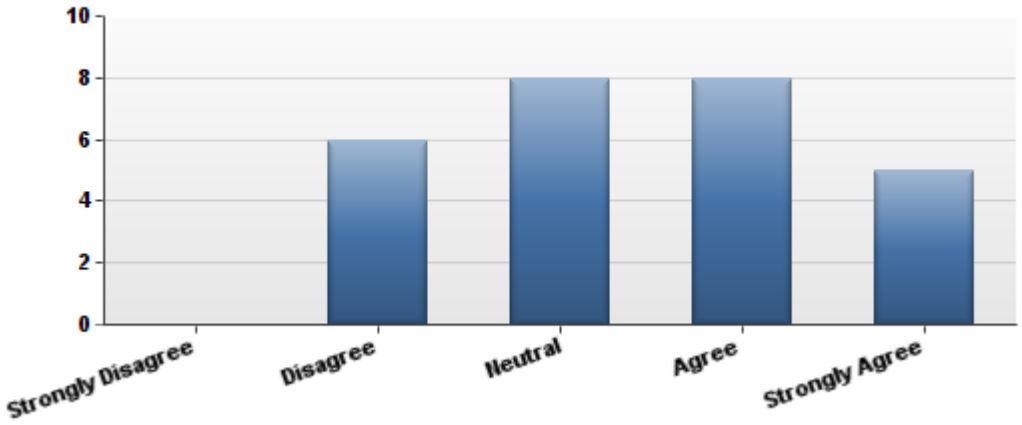


#	Answer		Response	%
1	Strongly Disagree		0	0%
2	Disagree		5	18%
3	Neutral		14	50%
4	Agree		8	29%
5	Strongly Agree		1	4%
	Total		28	100%

Statistic	Value
Min Value	2
Max Value	5
Mean	3.18
Variance	0.60
Standard Deviation	0.77
Total Responses	28

“The game had some form of rich and unique art, through graphics, sound, or another area of design (Question 7).”

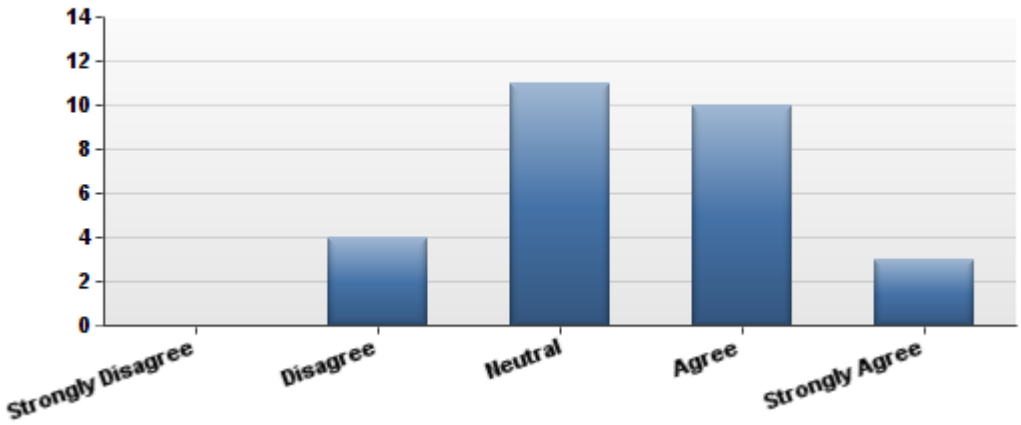
A plurality of 49% found enjoyed the looks of the game. Faults with games were most likely found in other aspects of the games.



#	Answer		Response	%
1	Strongly Disagree		0	0%
2	Disagree		6	22%
3	Neutral		8	30%
4	Agree		8	30%
5	Strongly Agree		5	19%
	Total		27	100%

Statistic	Value
Min Value	2
Max Value	5
Mean	3.44
Variance	1.10
Standard Deviation	1.05
Total Responses	27

“The game's story/storyline was compelling and interesting, providing me with an interesting experience (Question 6).”
Only 14% of subjects responded negatively. Therefore we speculate that the story lines in most cases did not take away from gaming experience. In 47% of cases it enriched gaming experience.

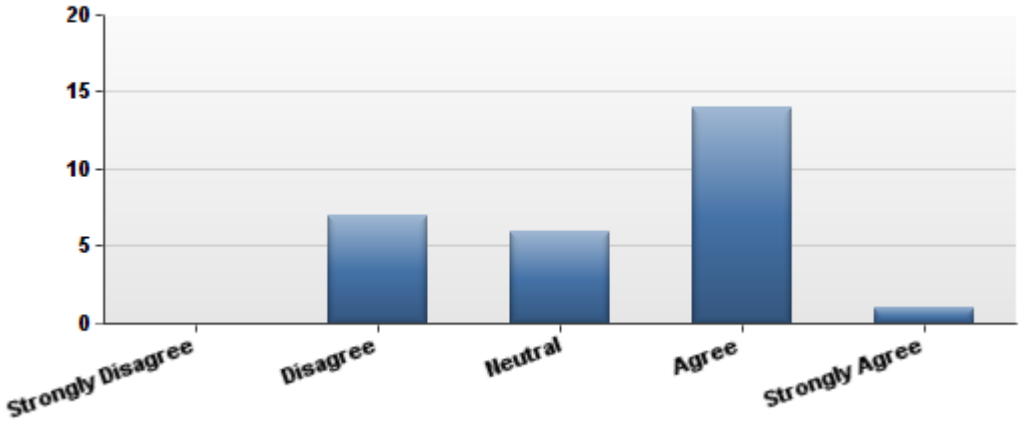


#	Answer		Response	%
1	Strongly Disagree		0	0%
2	Disagree		4	14%
3	Neutral		11	39%
4	Agree		10	36%
5	Strongly Agree		3	11%
	Total		28	100%

Statistic	Value
Min Value	2
Max Value	5
Mean	3.43
Variance	0.77
Standard Deviation	0.88
Total Responses	28

“The game provided me with different challenges. The objectives were never the same. For example, in one challenge I may need to save a character, and in another I need to stop an enemy (Question 8).”

A majority of subjects found in game challenges to be diverse.



#	Answer		Response	%
1	Strongly Disagree		0	0%
2	Disagree		7	25%
3	Neutral		6	21%
4	Agree		14	50%
5	Strongly Agree		1	4%
	Total		28	100%

Statistic	Value
Min Value	2
Max Value	5
Mean	3.32
Variance	0.82
Standard Deviation	0.90
Total Responses	28

“What did you particularly enjoy about the game (Question 29)?” Below are all the written responses.

“I enjoyed the fact that the phone would act as a pedometer to track the distance and pace that I ran.”

“I felt that the workouts were very legitimate and if I followed them for an extended amount of time, I would be very successful.”

“The layout was appealing and easy to use. If I had more predetermined exercise goals this app would serve as a useful to keep track of such activities and maybe promote me to do more.”

“I enjoyed the fact that the amount of exercise I completed was converted into some way of helping different organizations, such as funding antiretroviral pills for RED.”

“Would add some sort of story line instead of simply having an app that acted as a tracker."

“Would make the instructions clearer"

"Change the ‘news feed’-like starter page that’s been apparent in these types of games"

"I would make it a little more technical."

"At least provide a singular option for plans that does not require friends to be invited; without the option gameplay was limited and made me feel slightly uncomfortable without the experience in using the app."

"I would have made the interface a bit more engaging, like making the tracker for funds more animated."

"Better interface design."

"I would make it a bit easier to navigate through the game. It was not necessarily hard but users who are unfamiliar with using smartphones may have problems."

"Make more levels, Make individuals increase in difficulty with success."

"I would make the menu a bit easier to navigate. It may prove to be difficult for people who are not well accustomed to smart phones."

"Have unlockable themed music; that'd be fun?"

"Make it harder."

"Made it less boring and more interactive."

"More like Ingress?" (Ingress is an augmented reality MMO game by developed by Google)

"Make it less lame."

"I would remove the story lines. The "rewards" didn't affect my enjoyment of the game, so they just feel superfluous."

"I would put in some full month plans for free."

"I would make the game more sensitive to the movements it's looking for."

4.2.9 In Game Advertising

“If the game featured advertisements, purchases, or other options, how often did you click to learn more about the shown content per gaming session (Question 17)?”

We neglected to add in an answer for 0 interactions. Answers for response #1 should more accurately be read as 0-2 interactions. From the data and select responses below, we speculate that mobile users have their overall enjoyment of applications diminished by advertising. Some games had advertising and others didn’t. Some subjects did not answer this question. Subjects found ads to be distracting and irritating.

#	Answer		Response	%
1	1-2		21	100%
2	3-4		0	0%
3	5-6		0	0%
4	>6		0	0%
	Total		21	100%

“If the game featured advertisements, did you find that these options improved or worsened the game (Question 28)?” Below are distinct responses.

“I didn't notice any advertisements while playing. I answered 1-2 above because I wasn't sure if the survey would work if I left a question blank.”

“A lot of the ads that came up encouraged the use of integrating the app with more than one social networking site (eg, Twitter, blogs), which I found to be distracting, and at some points irritating.”

Many other users responded with unenthusiastic comments such as “Meh” and “Worsened”

5. Conclusion

Overall, subjects responded neutrally to these games. There are a variety of explanations for the general neutral response from subjects. One reason is the season in which this study was conducted. As the study took place during the winter, and since most applications forced the participants to exercise outside, participants likely faced cold weather, slippery ice, wet snow, and other non-optimal conditions. Participants may not have tested the application as long as they would have liked. A second possibility is the resources already available for subjects to exercise with. All study participants were WPI students with full access to the new Sports & Recreation Center. Along with this, WPI already features mandatory gym classes, and students must do quite a bit of walking around campus. Because of this, students may feel as though these games were not useful for themselves and cared very little for the apps. A third reason is that participants were not given enough time to test the game. Participants may not have been able to replay the game enough times to become truly acquainted with its mechanics and features. Also, a large variety of games feature content that cannot be unlocked within only 30 minutes of gameplay. Without getting a true feel for the game, participants would react neutral to a response. Along with these reasons, the participant's history with exercise was not taken into account. Participants may have already had an athletic background, finding no need or desire for these games.

The team and participants did find that games lacked depth in story and gameplay, but made up for it in the quality of statistics tracking and worthwhile physical challenges. There are a few ways in which developers should attempt to improve mobile health games. One important requirement is that advertisement must be kept to a minimum; players vastly disliked them. Another requirement is that games should only integrate social features in a non-interfering and minimalistic way. Most participants of this study reacted negatively to the social networking features, but they also did not have the time to incorporate the games into their lives, nor did they play with other participants. Overall though, being bombarded with pop-ups asking to share a score in a game with Facebook, Twitter, and every other social website annoys players. Only a select set of social sites should be integrated with a game. Games were found to be well developed, featuring great art and gameplay, and they were found to be very interactive. It is important for gaming apps to continue being well developed, functioning as a true video game while offering methods, information, and stats for exercising.

Most of the data received from the participants aligned with our expectations. Due to the time, weather, and other constraints faced during the study, we expected participants to be unable to form a regular workout schedule using these apps, and suspected that they would be unable to exercise enough before noticing any health improvements. When asked if the games established a regular exercise pattern participants responded with a majority of 'neutral' and 'disagree' and when asked if they noticed any improvements in their health participants responded with only 'neutral' and 'disagree'. Along with this, we also expected in game advertisements to be highly disliked. Advertisements rarely feature content that is relevant to the user, and even then it is an unwanted disruption in their use of the app. In line with this, all participants clicked on an advertisement under 2 times.

Some of the responses from the participants did surprise us. We had expected that users might have difficulty installing and launching the games, and that the instructions for a fitness game would be unusual and quirky. Despite this participants responded positively towards the ease of use questions. The majority of participants answered 'agree' when asked if they found the game's instructions to be easy to understand, and the majority answered either 'strongly agree' or 'agree' when asked if installing the game was easy. We believe our assistance with the participants in person helped to clear any confusion about our study and the games. We had also suspected that the participants would be less impressed about games targeted for health fitness. Compared to AAA games (games made with the highest budgets and skill, such as Nintendo games) we had believed that the art and content in mobile games would fall short. Although the selected health games were made with fewer resources, participants actually found the games to be well developed. Most participants responded positively when asked if they found the game to have unique art through graphics, sound, or a different area of design. Many participants found the game's storyline to be compelling and interesting, with only a very few amount of 'disagree' responses. The majority of participants agreed that the game provided them with different challenges. Though the games appear to be well designed, as the users enjoy the art and story, the gameplay mechanics and the variety in game challenges still needs improvement. Most users stated they would not replay the games in the future as a result of these issues.

Appendix A: IRB and Consent Forms

Informed Consent Agreement for Participation in a Research Study

Investigators: Massa, Nicholas Jackman, James Carli-Dorsey, Alex

Contact Information:
nbmassa@wpi.edu jdjackman@wpi.edu alcarlidorsey@wpi.edu

Title of Research Study:

Assessment of Mobile Fitness Games

Introduction:
You are being asked to participate in a research study. Before you agree, however, you must be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks or discomfort that you may experience as a result of your participation. This form presents information about the study so that you may make a fully informed decision regarding your participation.

Purpose of the study:
Our goal is to investigate the rise and current status of mobile video games in physical health applications, discover the efficacy qualities and criteria of health games, and determine how future games should be designed in order to achieve a larger audience of health game players and to promote general health and fitness among target populations.

Procedures to be followed:
In order to achieve our objectives, we require information from general owners of Android-based smart phones and iPhones. If you volunteer in this study, you will be asked to download and install three free mobile health game applications on your personal phone, and you will be asked to play/use these mobile games during a nine day period regularly. An information session will be held, with pizza, to assist the installation process as well as provide more information in person. After playing a game for three days, you will complete a standard questionnaire online through Qualtrics, and be asked a few questions. These questions will ask about your thoughts and opinions of the game you played. There will be one survey completed per game, resulting in three survey forms completed total. We will also ask for your ideas about how future health gaming applications should be developed.
In general, each application will track your fitness utilizing your phone's GPS, making calculations based on your distance traveled. Most mobile health games will require you to run at a comfortable pace for up to 10 minutes per session. Depending on the game, the running may be a set path or it may be a changing location.
Some applications do not utilize running. Teemo, for instance, requires you to perform a variety of stationary workouts. Teemo may simulate a number of activities such as 'Summit' and 'Swimming Superman'. However, you do not need to actually summit a mountain, and no actual swimming is expected; it is simply an exercise regimen for you to perform in place. No applications including Teemo require outside tools or gym equipment. Only the application itself is needed. Please note the differences you may feel from playing an exercise based application compared to a running application. Some applications may require more activity than others, such as Couch-to-5k, a game where the goal is to reach 5 km or 3.1 miles (though, as a paid application, we will not ask you to play this game). It is not necessary to complete an application if the challenge is too high. Do not place unnecessary stress on your body. Simply play the game a few times per day for three days, and fill out the survey. Please note the difficulties you found attempting to exercise with the game, or lack thereof.

Risks to study participants:

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Subjects will need to take into consideration the same risks and discomforts that any other Android or iPhone owner using their cell phone outside would need to take. These apps are publicly available and there are no additional risks associated with this study. Individuals who have preexisting medical conditions are advised not to partake in this study.

Benefits to research participants and others:
Subjects will not directly receive financial compensation from us, but may notice an improved quality of health, and they may keep any application they download. They will also receive free pizza during our information sessions, if they attend. The research will help us identify the areas that need improvement in mobile health games, and it will allow us to provide more substantial game reviews. Reviews will be publicly available for potential use by mobile application developers, who are interested in creating better health games, or for smart phone users hoping to find a health game that works for them.

Record keeping and confidentiality:
Questionnaire forms will be secured by our IQP team, until all information is uploaded digitally, and the rest destroyed. The digital information will be kept in WPI's secure servers for 3 years. The information gathered will remain confidential, even within the report.

Compensation or treatment in the event of injury:
We do not take any responsibility in the event of an accident while testing or playing a mobile application. You do not give up any of your legal rights by signing this statement.

For more information about this research or about the rights of research participants, or in case of research-related injury, contact:
(Contact information of investigators available at the top of these pages.)
IRB Chair (Professor Kent Rissmiller,
Tel. 508-831-5019, Email: kjr@wpi.edu)
University Compliance Officer : Michael J. Curley,
Tel. 508-831-6919, Email: mjcurley@wpi.edu

Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you or any loss of benefits to which you may otherwise be entitled. You may decide to stop participating in the research at any time without penalty or loss of other benefits. The project investigators retain the right to cancel or postpone the experimental procedures at any time they see fit.

By signing below, you acknowledge that you have been informed about and consent to be a participant in the study described above. Make sure that your questions are answered to your satisfaction before signing. You are entitled to retain a copy of this consent agreement.

_____ Date: _____
Study Participant Signature

Approved by
WPI IRB 1
1/10/14-1/9/15

_____
Study Participant Name (Please print)

_____ Date: _____
Signature of Person who explained this study

Approved by
WPI IRB 1
1/10/14-1/9/15

Worcester Polytechnic Institute IRB# 1
HHS IRB # 00007374

10 January 2014
File: 13-255

Re: IRB Expedited Review Approval: File 13-255 "Assessment of Mobile Fitness Games"

Dear Prof. Tulu,

The WPI Institutional Review Committee (IRB) approves the above-referenced research activity, having conducted an expedited review according to the Code of Federal Regulations 45 (CFR46).

Consistent with 45 CFR 46.116 regarding the general requirements for informed consent, we remind you to only use the **attached stamped approved consent form** and to give a copy of the signed consent form to your subjects. You are also required to store the signed consent forms in a secure location and retain them for a period of at least three years following the conclusion of your study. You may also convert the completed consent forms into electronic documents (.pdf format) and forward them to the IRB Secretary for electronic storage.

The period covered by this approval is 10 January 2014 until 9 January 2015, unless terminated sooner (in writing) by yourself or the WPI IRB. Amendments or changes to the research that might alter this specific approval must be submitted to the WPI IRB for review and may require a full IRB application in order for the research to continue.

Please contact the undersigned if you have any questions about the terms of this approval.

Sincerely,

Kent Rissmiller
WPI IRB Chair

Appendix B: Qualtrics Survey

Assessment of Mobile Fitness Games Survey

1.) By clicking "I Agree" below, you state that you have been given this survey by the Assessment of Mobile Fitness Games IQP group, have signed the provided consent form, and that you have tested each game for a period of at least three days. Participants must meet these requirements to continue.
- ❍ I Agree (1)
- ❍ I Disagree (2)

2.) Are you a SONA Participant?
- ❍ Yes (1)
- ❍ No (2)

3.) What is your SONA number for this study?

4.) Thank you for considering this survey. Unfortunately, you do not meet the requirements required to take this.

5.) Which game are you responding to?
- ❍ StreetQuest (Android) (1)
- ❍ Tourality (Android) (2)
- ❍ Nexercise (Android) (3)
- ❍ Ingress (Android) (4)
- ❍ SpecTrek Light (Android) (5)
- ❍ Fitrocracy (Android) (6)
- ❍ SCVNGR (Android) (7)
- ❍ Charity Miles (Android) (8)
- ❍ NF Free (iPhone) (9)
- ❍ Teemo (iPhone) (10)
- ❍ Healthy Heros (iPhone) (11)
- ❍ FitQuest Lite (iPhone) (12)
- ❍ Nexercise (iPhone) (13)
- ❍ Charity Miles (iPhone) (14)

6.) The game's story/storyline was compelling and interesting, providing me with an interesting experience.
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Neutral (3)
- ❍ Agree (4)
- ❍ Strongly Agree (5)

7.) The game had some form of rich and unique art, through either graphics, sound, or another area of design.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Neutral (3)
- ❍ Agree (4)
- ❍ Strongly Agree (5)

8.) The game provided me with different challenges. The objectives were never the same. (For example, in one challenge I may need to save a character, and in another I need to stop an enemy.)

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Neutral (3)
- ❍ Agree (4)
- ❍ Strongly Agree (5)

9.) I felt I had a strong influence on the game. The choices I made greatly affected gameplay outcomes.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Neutral (3)
- ❍ Agree (4)
- ❍ Strongly Agree (5)

10.) The game was not too linear. I had a large selection of challenges, the same challenges could be played in a variety of orders, and there were multiple ways to achieve my goal.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Neutral (3)
- ❍ Agree (4)
- ❍ Strongly Agree (5)

11.) The game made me move in a variety of ways. I did not simply move in a circle, or straight line.

- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Neutral (3)
- ❍ Agree (4)
- ❍ Strongly Agree (5)

12.) Downloading, launching, and beginning to use the game was simple and straightforward.
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Neutral (3)
- ❍ Agree (4)
- ❍ Strongly Agree (5)

13.) It was easy to navigate through the game's various menus and options.
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Neutral (3)
- ❍ Agree (4)
- ❍ Strongly Agree (5)

14.) I was able to learn game mechanics and controls quickly and with little trouble or effort.
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Neutral (3)
- ❍ Agree (4)
- ❍ Strongly Agree (5)

15.) I found this game's instructions to be relatively easy to understand.
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Neutral (3)
- ❍ Agree (4)
- ❍ Strongly Agree (5)

16.) The game features multiple game levels which motivate me to continue playing.
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Neutral (3)
- ❍ Agree (4)
- ❍ Strongly Agree (5)

17.) The game's social networking features are well integrated and motivate me to continue playing this game.
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Neutral (3)
- ❍ Agree (4)
- ❍ Strongly Agree (5)

18.) There are other changes, such as unlockable content, that motivate me to continue playing.
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Neutral (3)
- ❍ Agree (4)
- ❍ Strongly Agree (5)

20.) The physical exertion provided by the game challenged me adequately, but was within my capabilities.
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Neutral (3)
- ❍ Agree (4)
- ❍ Strongly Agree (5)

21.) The game tracks helpful stats that show my physical performance, such as calories burnt or miles ran.
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Neutral (3)
- ❍ Agree (4)
- ❍ Strongly Agree (5)

22.) As a result of playing this game, I have seen noticeable improvements in my exercise habits.
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Neutral (3)
- ❍ Agree (4)
- ❍ Strongly Agree (5)

23.) This game helped me establish a regular exercise schedule.
- ❍ Strongly Disagree (1)
- ❍ Disagree (2)
- ❍ Neutral (3)
- ❍ Agree (4)
- ❍ Strongly Agree (5)

24.) How many times did you play the game?
- ❍ 1-2 (1)
- ❍ 3-4 (2)
- ❍ 5-6 (3)
- ❍ 7-8 (4)
- ❍ 9-10 (5)
- ❍ >10 (6)

25.) On average, how long did you play the game each time?
- ❍ < 10 minutes (1)
- ❍ 10-20 minutes (2)
- ❍ 20-30 minutes (3)
- ❍ > 30 minutes (4)

26.) How well did you feel you performed in the game? (Was your score below or above average?)

27.) If the game featured advertisements, purchases, or other options, how often did you click to learn more about the shown content per gaming session?
- ❍ 1-2 (1)
- ❍ 3-4 (2)
- ❍ 5-6 (3)
- ❍ >6 (4)

28.) If the game featured advertisements, did you find that these options improved or worsened the game?

29.) What did you particularly enjoy about the game?

30.) What did you particularly dislike about the game?

31.) What changes to the game would you have done if you were a game developer?

32.) What is your overall rating of the game?
- ❍ 1 (Worst) (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (Best) (5)

33.) Do you see yourself playing this in the future?
- ❍ Yes (1)
- ❍ No (2)

34.) What is your age?
- ❍ 18-20 (1)
- ❍ 21-25 (2)
- ❍ 26-30 (3)
- ❍ 31-35 (4)
- ❍ 36-40 (5)
- ❍ >40 (6)

35.) What is your gender?
- ❍ Male (1)
- ❍ Female (2)
- ❍ Other (3)

36.) What background or ethnicity do you identify with?
- ❍ Caucasian (1)
- ❍ Hispanic or Latino (2)
- ❍ African American (3)
- ❍ Native American (4)
- ❍ Asian American/Pacific Islander (5)
- ❍ Other (6)

37.) How many years have you played mobile games?
- ❍ 1-2 years (1)
- ❍ 3-4 years (2)
- ❍ >5 years (3)

38.) How many years have you owned a smart phone?
- ❍ 1-2 years (1)
- ❍ 3-4 years (2)
- ❍ >5 years (3)

39.) What is your affiliation with WPI?
- ❍ Freshman (1)
- ❍ Sophomore (2)
- ❍ Junior (3)
- ❍ Senior (4)
- ❍ Graduate Student (5)
- ❍ Employee (6)
- ❍ Not Affiliated with WPI (7)

40.) How did you find out about this study?
- ❍ E-Mail (1)
- ❍ SONA (2)
- ❍ Campus Center Table (3)
- ❍ Flyer (4)
- ❍ Word of Mouth (5)
- ❍ Other (6)

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